Lexical access and representations in children : naming and word learning

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Link(s) to article on publisher's website:
http://dx.doi.org/doi:10.21954/ou.ro.0000fa59

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Lexical Access and Representations in Children:

Naming and Word Learning

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Thesis submitted for the degree of Doctor of Philosophy

Psychology

The Open University

31st May 2007

DATE OF SUBMISSION 31 MAY 2007

DATE OF AWARD 15 FEBRUARY 2008

ABSTRACT

This thesis is concerned with naming and word learning in typical children. The investigations of naming concerned lexical processes and representations associated with children's quick and accurate picture naming. The investigations of word learning concerned the development of naming processes and representations during word learning.

The aim of the investigations of naming was to better understand the way that different cognitive processes contribute to the speed and accuracy of discrete and serial naming. The contribution of age, gender, semantic abilities, phonological abilities and speed of response to non-lexical stimuli was analysed in relation to children's speed and accuracy of naming. The findings indicated that age, but not gender, was related to the naming process; that different processes are involved in discrete and serial naming, and that speed of non-lexical information processing speed appeared to be an important variable to accurate (and fast) naming. Additional analyses on a sample of children with Word Finding Difficulties concerned errors and the role of lexical factors in the naming process. These findings revealed that lexical factors were not as important as participant characteristics, such as age or language ability.

The aim of the investigations of word learning was to assess the role of semantic and phonological information in relation to the development of lexical representations. Children learnt a set of nonsense words and their knowledge of these words was assessed using a comprehensive range of tasks involving different lexical abilities. The children had greater difficulty with assessments of production than assessments of comprehension, and did poorly on tasks involving the retrieval of semantic representations. In addition, comparisons of the effectiveness of different types of input revealed that visual input was most effective and that children were able to use information from one modality to form lexical representations in another modality.

The implications of these findings for existing knowledge about typical populations, as well as for understanding atypical development, are discussed.

ACKNOWLEDGEMENTS

My grateful thanks go to my supervisors Professor David Messer and Professor Julie Dockrell for their investment in this work and for their valuable advice and encouragement. Particular thanks to Professor David Messer for his dedicated patience and availability throughout the PhD.

I am indebted to the staff and children who welcomed me into their schools and classrooms, and for being most helpful and cooperative. I would particularly like to thank the following schools: St Peter's Primary School, Charles Dickens and Tower Bridge Schools in London and Dame Alice Harpur School (Junior School) in Bedford.

The following people have also provided much help: Simon Noyce and Krist Noonan for their technical expertise and availability; Steve Lerman; Martin Woodhead; Lesley Messer; Fiona Harris for her much appreciated kindness and encouragement. I would also like to thank Nathalie Pross for her friendship.

This work would not have been possible without the tremendous support and ongoing encouragement of my dearest parents. Mami & Papi: my heartfelt gratitude for being there every step of the way and for supporting and believing in me.

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CHAPTER I

LEXICAL ACCESS AND NAMING IN TYPICAL CHILDREN

1. Introduction – Importance of naming

The processes of lexical retrieval and naming are fundamental for language and conversation. Naming objects is something we do everyday, seemingly without much effort (Humphreys & Riddoch, 1987; Levelt, Roelofs & Meyer, 1999). However, several researchers have found that the apparent simplicity of the task underlies the numerous operations that are involved in this process (Maess, Friederici & Damian, 2002; Vukovic & Siegel, 2006). As claimed by Levelt et al. (1999), "*the underlying process [...] is exceedingly complex*" (p. 1). Indeed, although naming appears to proceed effortlessly, this process reflects "*the surface of a continuum of interconnecting perceptual, cognitive, and linguistic sub-processes, each of which is necessary for the normal retrieval of words to occur*" (Wolf & Segal, 1992; p. 53). According to Goodglass (1980) the successful retrieval of words from the mental lexicon involves cognitive and temporal sub-processes that consist of both lower-level (i.e. attentional, visual, perceptual, sequencing, unpacking relevant motor programmes) and higher-level (i.e. cognitive and lexical) processes; and where each of these sub-processes is necessary for the successful retrieval of words (see also Jolicoeur, Gluck & Kosslyn, 1984; Lahey & Edwards, 1996). It is therefore assumed that if the integrity of any of these processes is compromised, naming would be affected. The focal point of this research is the investigation of word-retrieval processes in typical primary school age children.

CHAPTER I: Literature Review Pt. 1

In instances of daily life, we all experience difficulties in retrieving words at one time or another. However, persistent difficulties in retrieving verbal labels appear to be a prevalent, or consistent, feature of many children with language disabilities. Disruptions of the naming activity have been found in children with Word Finding Difficulties (Dockrell, Messer & George, 2001; McGregor & Waxman, 1998); Specific Language Impairment (Lahey & Edwards, 1996; Windsor & Hwang, 1999); or developmental dyslexia (Catts, Gillispie, Leonard, Kail & Miller, 2002; Wolf & Bowers, 1999). An extensive literature is available about the naming deficits of atypical children. However, it is also important to know more about typical naming processes, not only because of the structural complexity of the naming process (Goodglass, Kaplan, Weintraub & Ackerman, 1976; Howes 1966), but because disruption of the naming activity can also impact on other areas of development such as: literacy difficulties (Bashir & Scavuzzo, 1992; Menyuk, Chesnick, Liebergott, Korngold, d'Agostino & Belanger, 1991; Wolf, 1984), communicative and socio-emotional behaviour problems (German & Simon, 1991; Janksy & De Hirsh, 1992; Wallach & Butler, 1995), or poor academic achievement (Aram & Hall, 1989; Bashir, Wiig & Abrams, 1987; Snyder & Godley, 1992).

Several issues will be discussed in the following sections. First, models of word production, based on psycholinguistic work conducted with adults, will be presented. This will comprise an overview of discrete and non-discrete models of adult word production, then a discussion of models of naming in relation to children. In a second section, the role of lexical representations (i.e. semantic and phonological), as well as the role of speed of information processing, involved in the naming process will be discussed. The importance of these components of naming will be highlighted through the literature that is available from children with language disabilities.

II. The process of Lexical Production

Word finding consists in selecting a word from one's mental lexicon for subsequent production. Studies of naming processes have involved fluent discourse contexts and confrontational naming contexts (i.e. naming pictures). For the most part, naming processes have usually been examined through the use of pictures, considered as the basic task on which models of word-retrieval have been built (Goodglass, 1993). Models of naming identify pathways in the lexical architectural system and are useful in understanding why naming fails. Relevant to models of naming are measures of accuracy, latency, as well as the type of errors produced. These types of data have provided further insight into the nature (and integrity) of the representations involved in the naming process.

2.1. Models of Adult Lexical Production

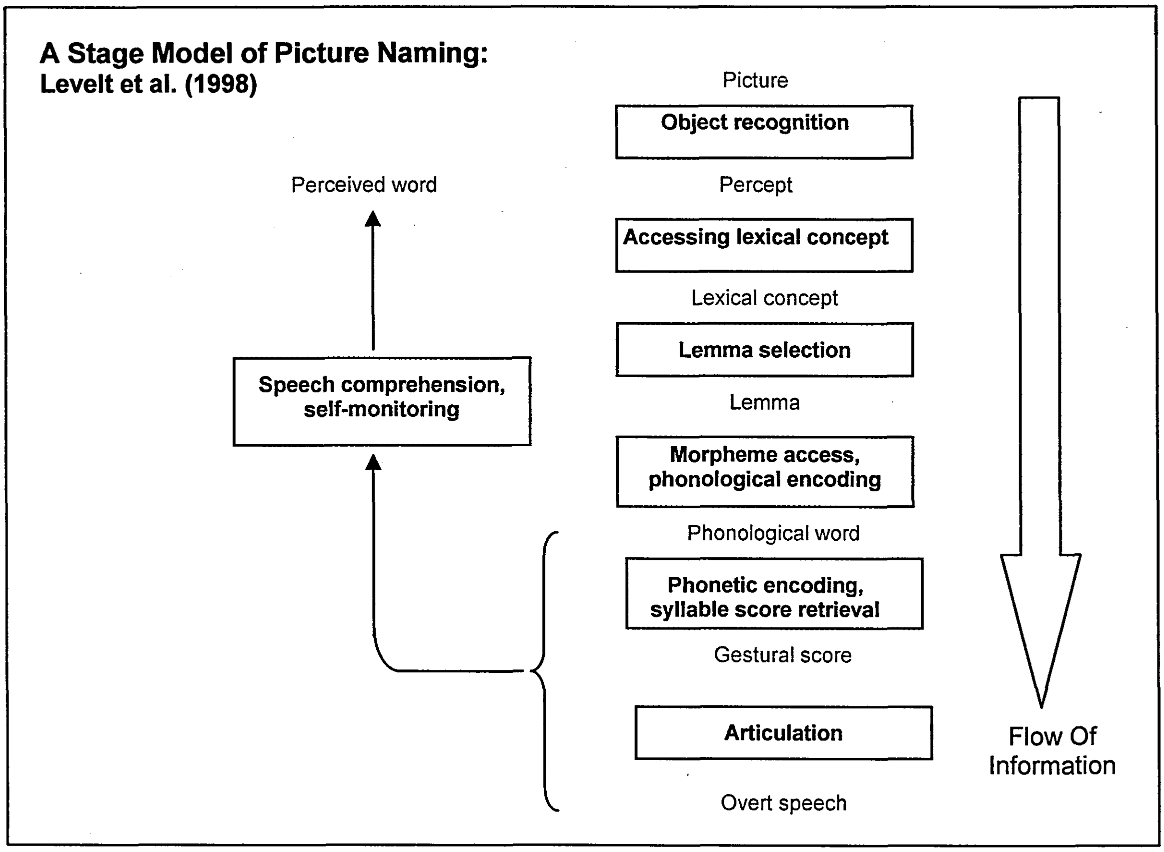
Detailed models of naming come from investigations of typical and atypical adults (Laine & Martin, 1996; Levelt, Vorberg, Meyer, Pechmann & Havinga, 1991; Levelt et al., 1999; Schiller, Bles & Jansma, 2003). Models usually differentiate between lexical-semantic and lexical-phonological activation phases in word production (Levelt, 1992). The precise nature of this relationship remains open to debate – with uncertainties about the exact number of stages (Goodglass, 1998), whether they unfold sequentially (Levelt et al., 1999) or concurrently (Dell, 1986; Martin, Dell, Saffran & Schwartz, 1994). Current models of lexical access in adults are usually described in terms of *discrete* or *non-discrete* models. These are detailed in the following paragraphs.

Theories of Lexical Access: Discrete Models

In models of adult naming the levels of lexical processing have been labelled as *lemma* and *lexeme*. The *lemma* level involves the meaning and syntax of a given entry (Levelt et al. 1999; Vigliocco, Vinson, Martin & Garrett, 1999), whereas the *lexeme* level specifies its phonological and morphological form (Caramazza, 1997; Kempen & Huijbers, 1983; Schwartz, Dell, Martin, Gahl & Sobel, 2006).

The Discrete Two-Stage model (DTS) proposed by Levelt and colleagues suggests that lemma and lexeme levels are accessed successively, in temporally distinct stages (Bock & Levelt, 1994; Jescheniak & Levelt, 1994; Levelt et al., 1991). Only once the lemma node has been selected, does activation spreads to the next stage of processing - i.e. to the lexeme level (Levelt et al., 1999). Thus, in discrete models, lemma and lexeme processing stages involve independent levels of representations (Caramazza, 1997; Garrett, 1991; Levelt, 1992; Levelt & Schriefers, 1987). There is also no feedback between those two levels as only *feed-forward* corrections are allowed. Figure 1 below (taken from Levelt, Praamstra, Meyer, Helenius & Salmelin, 1998) provides a simplified view of the pathways of naming according to the DTS model (also see Maess et al., 2002).

Figure 1: Conceptualisation of the discrete two-stage model of picture naming (from Levelt et al., 1998)

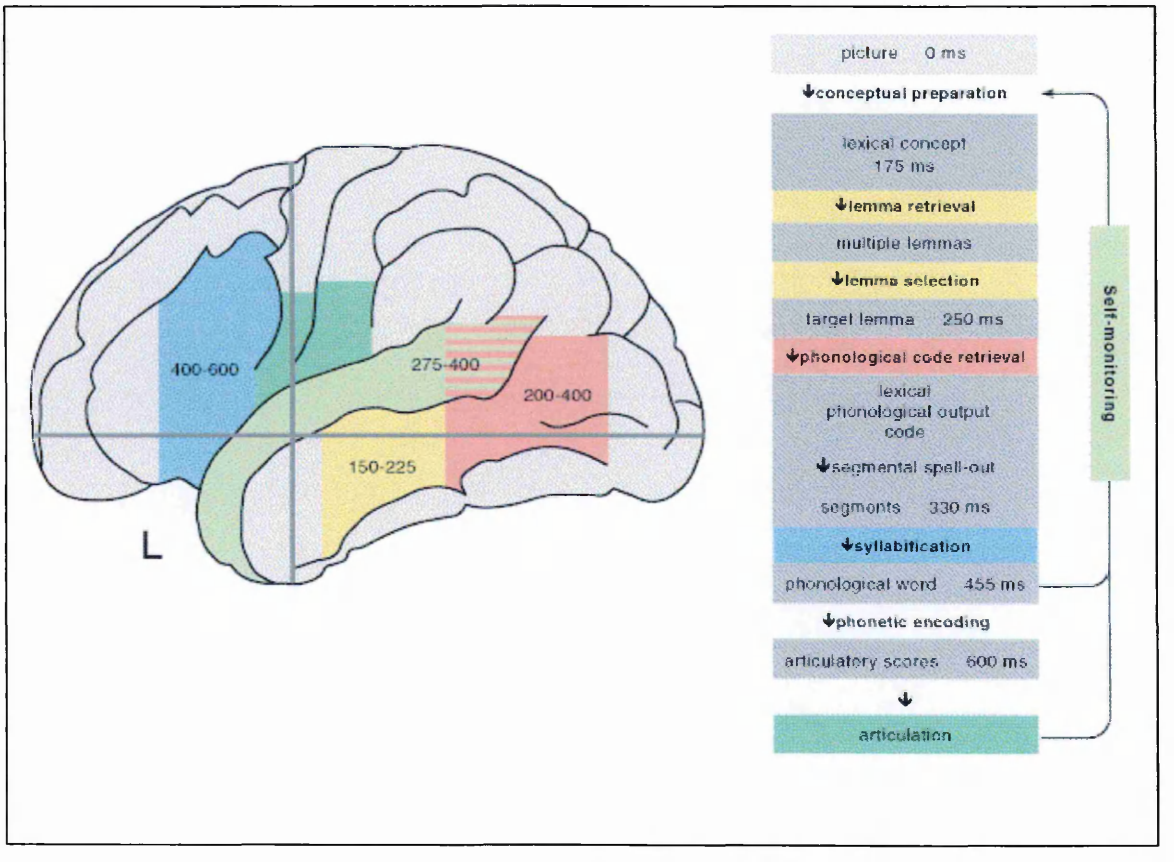


Support for the DTS model comes from several sources, such as the tip-of-the-tongue (TOT) phenomenon, where individuals appear to have some knowledge about the characteristics of the word (lemma level), but fail to retrieve its phonological form (see Brown, 1991 for review; Meyer & Block, 1992). According to Caramazza & Miozzo (1997), TOT studies provide clear evidence for the distinction between the two lexical nodes defined earlier. Additional support comes from studies of anomia (Badecker, Miozzo & Zanuttini, 1995) or aphasia (Caramazza & Hillis, 1990).

Arguments in favour of the DTS model also stemmed from chronometric work (Levelt et al. 1991; 1999) which examined the areas of the brain that were activated during naming and the duration of this activation. Data recorded from Positron

Emission Tomography or Magneto-Encephalography studies indicated that, when naming, each region of the brain was activated once only. These studies provided evidence for the two separate and temporally distinct stages - with the semantic activation phase preceding the phonological activation stage. Indefrey & Levelt (2004) have summarised these results in Figure 2.

Figure 2: Time course of lexical processes in speech production and activation of different regions of the brain (from Indefrey & Levelt, 2004)



One of the first chronometric studies comes from Schriefers, Meyer & Levelt (1990) who set up a picture naming task using a word interference paradigm (see also Levelt et al., 1991). The authors varied the stimulus onset asynchronies whereby participants heard the distracter (which could be semantically related, phonologically related or unrelated to the target picture) at 150 msecs before presentation of the target, simultaneously with the target or 150 msecs after presentation of the target. Analysis of the time course of the processes involved in speech production showed that its initial phase was affected by semantic manipulations whereas its later phases were affected by phonological manipulations (Levelt et al., 1991; Schriefers et al., 1990). Several researchers corroborated these findings (Goodglass, Wingfield & Ward, 1999; Schiller et al., 2003) that phonological activation occurs after the semantic activation phase. Goodglass and colleagues (1999) also found that activation of different components of the semantic system was distributed over time (i.e. some components were activated before others).

Non-Discrete Models of Lexical Access

A major distinction between discrete models and non-discrete models is that, for discrete models, "*the output from a completed earlier stage serves as input to the next stage*" (Goodglass, 1998; p. 288). In contrast, the characteristic of non-discrete models is that "*subsequent stages are activated while processing at the earlier stage is still in progress [or active]*" (Goodglass, 1998; p. 296). In other words, both lexeme and lemma candidates are activated simultaneously, i.e. prior to the selection of a lexeme candidate (Laine & Martin, 1996). A further distinction concerns the flow of information between those two stages:

Non-discrete cascade models (Blanken, Dittman & Wallesch, 2002; Costa, Caramazza & Sebastian-Galles, 2000; Cutting & Ferreira, 1999; Humphreys, Riddoch & Quinlan, 1988; Morsella & Miozzo, 2002) stipulate that the flow of information only allows *feed-forward* activation (Caramazza, 1997; Dell, Schwartz, Martin, Saffran & Gagnon, 1997; Peterson & Savoy, 1998). In other words, although both lemma and lexeme candidates are activated, there is no feedback from the lexeme to the lemma level.

In contrast, *non-discrete interactive models* (Dell, 1986; Martin, Dell, Saffran & Schwartz, 1994; Schwartz et al., 2006) assume that the flow of information is bi-directional with presence of feedback loops between and across different processing stages (Dell, Burger & Svec, 2002; Dell & Reich, 1981). As summarised by Schwartz (2006; p.230), interactive models are thus characterised by the fact that information "*flows up from phonology and down from semantics*" and where semantic and phonological processes can influence each other mutually.

As Laine & Martin (1996) summarised, the relationship between retrieval of semantic and phonological representations during word production remains an open issue. Furthermore, despite extensive research there remain uncertainties in ascertaining which model (discrete or non-discrete) best explains naming difficulties and/or account for error patterns when naming fails (Goldrick & Rapp, 2002; Martin et al., 1994; Rapp & Goldrick, 2000).

2.2. Typical Development: Children's Naming Processes

As discussed above, detailed models of naming come from investigations of adult speech production (Hillis & Caramazza, 1991; Levelt et al., 1999). There have been marked differences in the methods used to investigate adults' word production and studies of children's naming processes. As a result, models of children's naming are comparatively rare and less detailed (Constable, Stackhouse & Wells, 1997; Johnson, Paivio & Clark, 1996). Developmental models of lexical access consist mainly in adaptations of adult models (Johnson et al., 1996; Levelt, 1989; 1991). However, the direct transposition of such models to the understanding of children's processes has been criticised (Dollaghan, 1987; Kail, Hale, Leonard & Nippold, 1984; Leonard, Nippold, Kail & Hale, 1983; Thomas & Karmiloff-Smith, 2002). Nevertheless, adult models provide a context to investigate the process of naming in children. As with models of adult naming, the precise nature of this sequence remains subject to debate, although there have been attempts to address this issue (Constable et al., 1997; Johnson & Clark, 1988; Johnson et al. 1996 for review).

A different terminology is used to refer to lexical representations in work on adults and children. Adult models typically refer to lemma and lexeme stages of processing, whereas models of children's naming often refer to semantic and phonological stages. Although there are similarities between these different conceptualisations, it is important to recognise that the lemma/lexeme distinction concerns lexical representations that involve grammatical processes (Kempen & Huijbers, 1983; Levelt et al., 1999). As defined by Schwartz (2006; p. 229) the lemma refers to "*a wholistic lexical representation that is associated with grammatical information and [...] links up with a syntactic frame or procedures that control how words are sequenced and inflected*". In contrast, research in children has been concerned with the semantic and phonological stages of processing, and has largely ignored morphosyntactic processes.

Stages and Processes Involved in Children's Naming

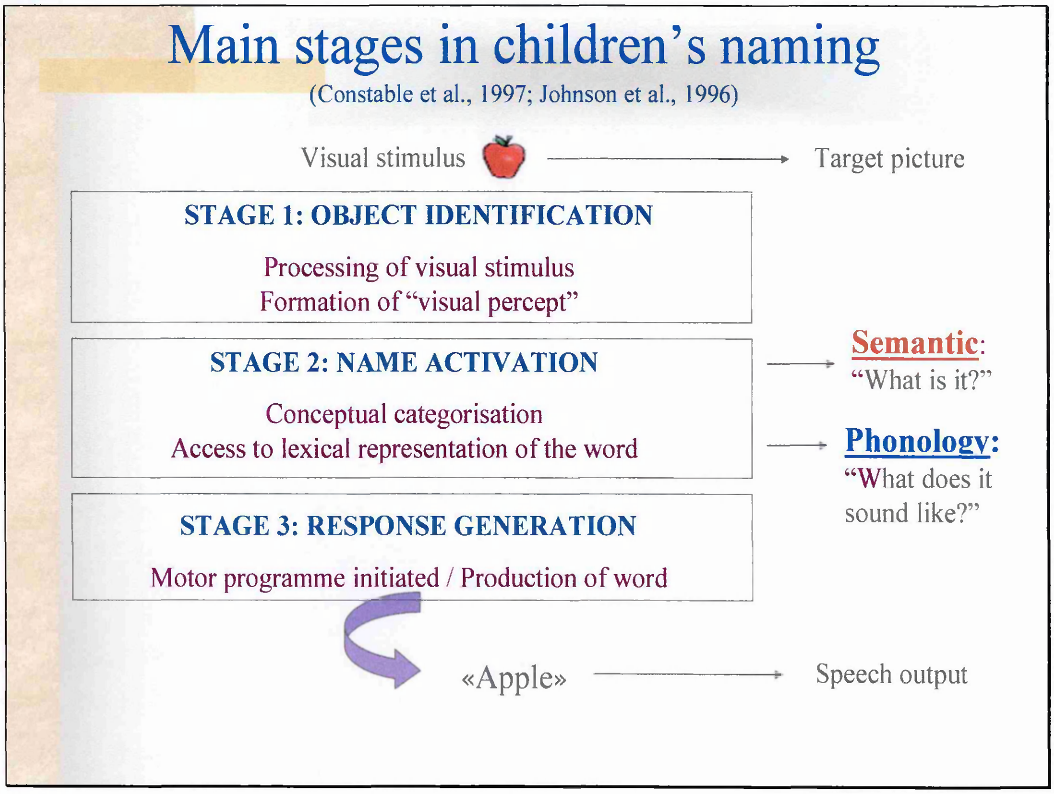
According to several researchers (Constable et al., 1997; Johnson et al., 1996; Glaser, 1992; Paivio, Clark, Digdon & Bons, 1989), naming in children involves at least three broad stages. These roughly correspond to stages identified in adult naming and consist of the following (see Figure 3 for an illustration of these stages):

The stage of "*object identification*" involves the processing of the salient perceptual features of the stimulus (i.e. the visual target), and leads to the formation of a so-called *visual percept* (Ratcliffe & Newcombe, 1982). During this stage, the stimulus is linked to the conceptual structure or underlying concepts associated with a target word (Bierwisch & Schreuder, 1991). A common feature of models of naming is that the stage of object identification (or object recognition) necessarily precedes the stage of lexical entry (German, 1989; Goodglass, 1993; McGregor, 1997).

A second stage of *conceptual categorisation* (or name activation) is where the visual stimulus maps onto a particular concept. Lexical representations of words are thus accessed and two types of information become available: information about the word's semantic properties (Levelt, 1999; Vigliocco, Vinson, Martin & Garett, 1999) as well as information about the word's phonological features (i.e. sound properties of the target word) in order to create a complete phonological schema. Support for the notion that semantic and phonological information are represented in different stores in early childhood stems from tip-of-the-tongue reports (Elbers, 1985; Faust, Dimitrovsky & Davidi, 1997).

A final stage of "*response generation*" consists in initiating a motor programme to generate the speech output (Johnson et al., 1996; Paivio et al., 1989). Specifically, a motor plan is created then forwarded to lower-level articulation processes (Monsell, 1986; Morton, 1985). The speech motor programming system then triggers production of the spoken word so that the participant can produce the word (Bierwisch & Schreuder, 1991; Johnson et al., 1996).

Figure 3: A simplified model of picture naming



In relation to typical development, the first phase of *object identification* is believed to unfold rapidly (Humphreys & Riddoch, 1987; Potter & Faulconer, 1975). According to Paivio & Csapo (1969), participants recognised pictures at the rate of 16 items per second (or 62.5ms per item). Likewise, once a word has been selected, the time taken during the stage of *response generation* in typical populations can be considered as a constant (Johnson et al., 1996 for review on typical development).

In summary: Investigation of children's naming processes has not been as detailed as adult investigations; although there are indications that similar basic processes are involved (Levelt et al., 1999). As Johnson and colleagues (1996) summarised, studies of children's naming have focused on the overall naming performance - with some analyses of error rate or role of lexical factors such as age-of-acquisition, word frequency, imageability to naming response (Garlock, Walley & Metsala, 2001; Metsala, 1997; Newman & German, 2002; 2004). There has not been much consideration of the developmental aspect of naming in typical research. Therefore, as argued by Johnson (1992), it is unclear whether maturation affects all naming stages similarly or whether specific stages of naming are affected differentially. Thus, it would be of interest to investigate whether naming performance as a whole changes with development but also, whether the development of the semantic and phonological components of naming are affected differently across different age groups. Because this question has rarely been addressed in typical development, it was decided to take up this issue in the first part of the thesis focusing on naming processes (see Chapters II to V).

III. Lexical Representations Involved in Children's Naming

Research concerning children with language disabilities has highlighted the importance of semantic and phonological representations for successful naming. A straightforward message coming from research on children with disabilities is that different components of naming are affected in different groups of children.

The three following sections outline how deficits, either in the semantic or the phonological system, could cause impaired naming. The first section presents a body of evidence linking deficient semantic representations to naming difficulties. The second section presents evidence of the role of imprecise phonological representations to children's naming difficulties. A final section considers how slower speed of general information processing can lead to slower and/or more inaccurate naming.

3.1. Semantics and Naming

This section highlights how impairments to the semantic system result in inaccurate or slower naming. Semantic knowledge involves information about the meaning of words and how this information is organised and represented in memory. The semantic store is believed to be structured according to specific relations (Collins & Quillian, 1969) encompassing taxonomic, hierarchical and associative relations between concepts (Elbers & Wijnen, 1992; Rosch, 1975). There are thus different ways to assess semantic knowledge and different assessments can tap into different dimensions of semantic ability and thus involve different levels of complexity. One of the limitations of research into atypical populations of children is the restricted number of tasks used to assess their semantic ability. Nevertheless, evidence that a semantic deficit underlies naming difficulties is presented below.

Children with Language Impairments

Children identified with Specific Language Impairment (SLI) are described as exhibiting limitations and delays in language (Johnston, 1992; Leonard, 1998; Newbury & Bishop, 2005). According to Bishop (2006; p. 217), these children "*have major problems to talk despite showing normal development in all other areas*". Thus, despite being physically and emotionally intact (Bishop, 1997), children with SLI perform below the level expected from their age or IQ on a range of language assessments (Bishop, 2006). As Bishop (2004) claims, the main characteristic of children with SLI is "*when a child fails to make normal progress in language learning for no obvious reason*" (p.309). Thus, this condition is typically defined by exclusion i.e. where the language deficits appear in the absence of any hearing impairment, emotional/behavioural problems or neurological impairment (Bishop, 1992; Leonard, 1998; Miller, Kail, Leonard & Tomblin, 2001). In Leonard's (1998) review of SLI, the author shows how this condition does not refer to a homogeneous group of children. Indeed, children with SLI can experience literacy or naming difficulties (Conti-Ramsden, Botting & Faragher, 2001; Simkin & Conti-Ramsden, 2006).

It has been suggested that imprecise semantic representations are a cause of these children's naming difficulties (Kail & Leonard, 1986; Leonard, Nippold & Kail, 1983; Wiig & Becker-Caplan, 1984). For instance, Kail & Leonard (1986) argued that the lack of elaborate semantic representations is what ultimately impedes the retrieval of words for these children. McGregor, Newman, Reilly & Capone (2002) investigated the role of semantic representations in 6 year olds' discrete naming. Findings showed that the SLI sample made significantly more errors than typical age matches. The higher error rate of the SLI sample was linked to these children's limited semantic knowledge (assessed by drawing and definitions). In other words, children who had poorer drawings and who provided fewer (correct) elements of definitions tended to be poorer at picture naming. This study emphasised the importance (and integrity) of semantic knowledge for efficient naming. As McGregor summarised "*the degree of knowledge represented in [the] semantic lexicon makes words more or less vulnerable to retrieval failure*" (p. 998).

Lahey & Edwards (1999) examined a wider subset of children with SLI (4 to 9 years old) on several naming tasks. The authors made a distinction between children having an expressive deficit and those having an expressive and a receptive deficit. Findings indicated that the SLI sample was significantly less accurate than age-matched peers. The authors also found different 'deficits' according to the subgroup of children with SLI: phonological errors seemed to be characteristic of children with expressive problems. In contrast, a higher proportion of semantic errors was obtained with the sample who had both expressive and receptive problems. More recently, Sabisch, Hahne, Glass, von Suchodoletz & Friederici (2006) used event-related brain potentials to examine the semantic processing of words of children with SLI in relation to typical controls. The activation of specific brain areas indicated that children with SLI had difficulties with semantic processing and this is consistent with the presence of weaker semantic representations in relation to their word retrieval problems.

Another subset of children with language impairments are those with Word Finding Difficulties (WFDs). Children with WFDs have specific problems with naming and are characterised by an inability to produce words, despite possessing adequate non-verbal intelligence and adequate comprehension abilities. According to Dockrell and colleagues (2001), these children are believed to experience consistent, and specific, difficulties in retrieving words for production (Dockrell, Messer, George & Wilson, 1998; Messer & Dockrell; 2006a; German & Simon, 1991).

McGregor and colleagues have provided support for the hypothesis that children's word finding difficulties are caused by less elaborate semantic representations (McGregor, 1997; McGregor & Appel, 2002; McGregor & Leonard, 1989; McGregor & Waxman, 1998; McGregor & Windsor, 1996). For instance, McGregor (1997) investigated the word finding abilities of a sample of pre-school children (3 to 5 years old). When analysing the type of naming errors children made, McGregor reported a higher rate of semantic erroneous substitutions in the language-impaired sample (although these children made proportionately more errors of phonological type). Similar findings were reported by Dockrell and colleagues (Dockrell et al., 2001; Dockrell, Messer, George & Ralli, 2003) while investigating a similar age range of 6 to 7 year olds with WFDs. Children were assessed on a confrontational naming task (naming of actions, objects and individual letters and numbers). Findings indicated that the WFD sample was significantly less accurate than the age matched peers. Concerning the latency of naming, Dockrell et al. (2001) also found that the WFD sample was significantly slower when naming pictures that relied heavily on semantic information. These findings led these investigators to speculate that the cause of WFDs could be attributed to the presence of impoverished semantic representations in children's lexicon.

Children with Reading Disabilities: 'Poor Comprehenders'

A growing body of research has identified a sample of children experiencing reading comprehension difficulties (often with standardised scores below 85), despite possessing adequate decoding skills. These children have been labelled as 'poor comprehenders'. Investigations of poor comprehenders have shown that these children manifest difficulties in naming (Nation, Marshall & Snowling, 2001). Nation and colleagues (Nation & Snowling, 2000; Nation, Clarke, Marshall & Durand, 2004; Nation & Norbury, 2005) have argued that impaired semantic representations account for the slower and/or inaccurate naming of these children. For example, Nation & Snowling (1998a) examined 9 year old poor comprehenders on tasks tapping their semantic and phonological abilities. Compared with typical age-controls, poor comprehenders exhibited deficits in relation to their semantic processing abilities -

such as ascertaining whether words e.g. '*rug*' and '*mat*' (or '*boat*' and '*ship*') had similar meanings. In contrast, these children showed adequate phonological abilities, and had no difficulties in deciding that '*rope*' and '*hope*' (or '*rope*' and '*soap*') sounded the same. The authors concluded that "*variation in semantic skill [...] contributes to the development of skilled word recognition*" (p. 100). Similar findings highlighting problems with semantic processing, rather than phonological impairments, were reported in subsequent studies (Nation & Snowling, 2000 with 9 year olds; Hammill, Mather, Allen & Roberts, 2002 with 6 to 12 year olds). A similar procedure was used by Nation et al. (2004) with 8 year olds where children were assessed on measures of semantics (e.g. definitions, similarity judgment), phonology (e.g. nonword repetition, rhyme judgment) and morpho-syntax (e.g. repetition of sentences of varying length). The authors commented on the presence of 'non-phonological' difficulties, whereby both semantics and syntax were impaired.

Difficulties with the semantic aspect of processing have also been reported in older children. Nation et al. (2001) examined the picture naming skills of 13 year old children with dyslexia, poor comprehenders and reading age controls. The naming of children with dyslexia was significantly less accurate than that of typical peers – particularly on long words (which required more phonological information); they also made more errors of a phonological nature. Poor comprehenders were also significantly slower and less accurate at naming, but there was no effect of word length, thereby indicating that poor comprehenders had adequate phonological skills. However, these children struggled with semantics.

In summary: As can be seen, there is converging evidence that impaired semantic representations can explain the naming difficulties of a range of children (also see

Kail & Salthouse, 1994; Messer & Dockrell, 2006). Similar results emerge from studies examining typical development such as McGregor, Friedman, Reilly, Newman & Robyn (2002b). These sets of findings therefore emphasise the necessity to include measures of semantic ability when investigating typical children's naming.

3.2. Phonology and naming

This section considers the link between imprecise phonological representations and children's naming difficulties. As Leukowicz (1980) stated, phonological representations capture children's ability to reflect upon, or manipulate, the sound structure of words. There are different ways to assess phonological representations and different tasks are believed to tap into different types and levels of abilities. Findings from atypical children highlight the necessity to verify the integrity of phonological representations as these could cause slower and/or inaccurate naming.

Children with Language Impairments

As discussed above, numerous investigations have explained the naming errors of children SLI or WFDs as part of a semantic processing deficit. Nevertheless, several strands of research have also shown that language disabilities can be attributed to difficulties in forming phonological codes, and these in turn could be responsible for naming difficulties. A phonological account of SLI has been put forward by several researchers. Bishop, who has an ongoing interest in SLI, suggested that the acquisition of phonology was delayed in children with SLI - and this would explain their expressive difficulties (Bishop, 1979).

Gathercole & Baddeley (1990a) have shown that 7-8 year old children with SLI have difficulties in forming, and maintaining, adequate phonological representations in memory. The phonological representations that children formed were believed to be incomplete or fuzzy. Gillam, Cowan & Marler (1998) reported similar findings with 8 to 11 year old children with SLI. The authors found that the language-impaired sample had difficulties using, or retaining, phonological codes. The rapid decay of phonological representations was believed to be the cause of the deficit. Additional evidence for a phonological explanation of SLI is available (Chiat, 2001; Lahey & Edwards, 1999; McGregor & Leonard, 1994).

Word finding difficulties have also been linked with deficits to access phonological codes or to the presence of imprecise phonological specifications. Chiat & Hunt (1993) investigated a 6 year old boy with WFDs on assessments tapping into different stages of input and output processing. Findings showed a predominance of phonological errors. Another proposal that the problems of children with WFDs stem from imprecise phonological representations is contained in Constable et al.'s (1997) case study of a 7 year old boy with WFDs. Several tasks were used such as tasks assessing semantic knowledge, auditory lexical decision (tapping into phonological knowledge) and picture naming. Findings showed that the child had no difficulties in processing semantic information. However, there was evidence of "*pervasive deficits in phonological processing*" compared to chronological and vocabulary controls. The presence of imprecise phonological representations (or phonological deficits) was believed to underlie the source of WFDs. More recently German (2002) has also suggested that the locus of children's naming errors could be attributed to problems with phonological storage and phonological output representations. Another line of research has revealed that providing children with phonological cues facilitates word retrieval (Faust et al., 1997; McGregor, 1994; McGregor & Leonard, 1989; or Wing, 1990 who showed the effectiveness of phonological training compared to semantic elaboration training in a naming task).

As mentioned in the section dealing with semantics, several studies reported that semantic errors were the more frequent types of errors from samples of children with WFDs. Nevertheless, it appeared that these children had a higher proportion of phonological errors (Dockrell et al., 2001; 2003; McGregor & Appel, 2002). For instance, McGregor & Appel (2002) examined the performance of 5-6 year old children with SLI on a confrontational naming task, as well as on a serial naming task. Findings showed the presence of a higher rate of semantic errors. However, there was also presence of a non-negligible proportion of phonological errors highlighting the fact that "*sparse phonological input and output representations*" contributed to these children's naming difficulties (McGregor & Appel, 2002; p. 1). McGregor (1994; 1997) also put forward the suggestion that errors of a semantic nature might in actuality mask faulty phonological abilities. This was explained by the fact that children might make semantic errors because they cannot access the phonological form of a word. Therefore, children would revert to the use of a more accessible alternative of a semantic nature to mask those deficiencies at the phonological level (Caramazza & Hillis, 1990; Ellis-Weismer & Edwards, 2006 for recent review of the phonological account). As a result, naming errors which appeared to be semantic could be due to the "*deficient mapping of, or access to, phonological representations*" (McGregor; p. 1391). More recent work from Newman & German (2002; 2004) also indicated that lexical characteristics such as neighbourhood density (i.e. the number of phonological neighbours a target word had) influenced naming accuracy. These uncertainties suggest further research on naming errors is needed.

Children with Dyslexia and Reading Disabilities

Investigators of children with developmental reading disabilities have also argued that there is a phonological cause for the literacy and naming difficulties observed (Bradley & Bryant, 1983; Snowling, 1987; Stanovich, 1988; Stanovich, Siegel & Gottardo, 1997; Vukovic, Wilson & Nash, 2004). In addition, findings from studies have shown that these children made a disproportionate number of naming errors of a phonological nature (Snowling, 2000; Swan & Goswami, 1987a & b; Truman & Hennessey, 2006). To date, there is strong support in favour of the phonological account of dyslexia (Catts et al., 2002; Ramus, Rosen & Dakin, 2003a; Ramus, Pidgeon & Frith, 2003b; Snowling 1998). So much so, that some researchers have argued that the *core deficit* of reading disabilities resides in impairments of phonological awareness (Bruck, 1992; Hulme & Snowling, 1992; Shankweiler, Crain, Katz, Fowler, Liberman, Brady, Thornton, Lundquist, Dreyer, Fletcher, Steubing, Shaywitz & Shaywitz, 1995; Stanovich & Siegel, 1994) or related to phonological processing abilities (Carroll & Snowling, 2004; Parrila, Kirby & McQuarrie, 2004; Ramus et al., 2003a; Wolf & Bowers, 1999).

Some of the first studies of children with literacy difficulties showed that they were slower at serial naming than typical children (Denckla & Rudel, 1976a & b). However, subsequent studies also found that these children were also slower and more inaccurate on measures of discrete naming (Snowling, van Wagtendonk & Stafford, 1988; Swan & Goswani, 1997). Snowling et al. (1988) investigated 10 year old children with dyslexia on a discrete picture naming task. Findings showed that these children were significantly less accurate than typical chronological and reading-age peers on the naming task. This led the authors to conclude that the cause of the naming deficits in dyslexia can be attributed to deficient phonological retrieval. Similarly, Swan & Goswami (1997a & b) investigated children with dyslexia in relation to reading age and chronological age samples (average age of the dyslexic sample was 11 years). Children were assessed on a confrontational naming task and on 4 measures of phonological ability (syllable tapping, onset-rhyme judgment, phoneme tapping and initial-final phoneme judgment). Findings indicated that children with dyslexia were significantly poorer on the naming task with longer words, especially in relation to complex words (i.e. multi-syllabic words or low frequency words). The difficulty in retrieving known names indicated that there was "*a selective difficulty in retrieving the phonological codes of these names on demand*" (p. 349). The authors therefore concluded that the source of the naming difficulties of children with dyslexia reflected the presence of imprecise phonological representations. A number of recent studies reported similar conclusions concerning the implication of poorly specified phonological representations to these children's inaccurate naming (Shaywitz & Shaywitz 2005; Snowling, 2001)

More recently, Truman & Hennessey (2006) investigated a sample of 7 to 12 year old children with dyslexia on a naming task where the pictures varied according to frequency (low vs. high). Accuracy and latency data were recorded. Findings showed that the language-impaired sample was less accurate but also had longer response times than the typical matches. The authors concluded that the locus of naming difficulties for children with dyslexia resided in phonological representations - specifically at the level of output phonological representations. Additional support comes from the work of Boada & Pennington (2006) showing the added implication of input phonological representations to these children's impaired naming.

In summary. Sections 3.1. and 3.2. outlined how impairments in the semantic or phonological systems (such as imprecise or unelaborated representations) are seen as causing a range of children's naming difficulties. These findings therefore emphasise the need to consider the integrity and accessibility of lexical representations (i.e. semantics and phonology) to the study of naming processes. In addition, because much of the research about phonology has focused on phonological awareness (Catts & Kahmi, 1999; Nathan, Stackhouse, Goulandris & Snowling, 2004), there is a need to assess other sorts of phonological abilities – such as auditory lexical decision tasks (Martin & Saffran, 2002), which provide a direct assessment of phonological representations.

3.3. Speed of Information Processing and Naming

Speed-naming deficits are reported in a range of children with language disabilities. This has led researchers to consider the contribution of speed of information processing factors in relation to naming, and this has been approached in a number of ways. First, and this stems primarily from work on adults (see section 2.1.), speed of information processing has been investigated in relation to the time taken for each of the stages of naming to take place (Levelt et al. 1991; 1998; Schiller et al., 2003). However, there is a different perspective in relation to children with language and reading disabilities. One perspective views the slower processing speed on naming as linked to, or a product of, language impairment. Another viewpoint considers slower processing speed of naming as part of a more general impairment. The following sections will address these three issues.

3.3.1. Speed as the Time Course of a Mental Process in Speech Production

The reaction time paradigm has been used extensively to the study of adult's speech production processes (see section 2.1.). Levelt and colleagues (Levelt et al. 1991; 1998. 1999; Jescheniak & Levelt, 1994) have used timed picture naming tasks to identify which are the basic processing (or *planning* stages of naming, according to Schiller et al., 2003; p. 819) involved in the speech production of adults. Reaction time data was thus used to specify how the lexical entries are accessed and the duration of each stage. Table 1 below provides an illustration of the breakdown of the time taken for each of these stages according to Levelt et al. (1998).

Table 1: Time window illustrating the duration of naming stages based on adult models of speech production – as summarised in Levelt et al., 1998 (also see Schiller et al., 2003)

Estimate of time window after picture onset	Processes taking place
[0 – 150ms]	Visual processing and access to lexical concept
[150 – 275ms]	Lemma selection (Roelofs, 1992; Schmitt, Schiltz, Zaake, Kutas & Munte, 2001)
[275 – 400ms]	Phonological encoding (Roelofs, 1997; Indefrey & Levelt, 2004)
[400 – 600ms]	Articulation Durations of picture naming from 680ms (Jescheniak & Levelt, 1994) or 591ms (Levelt et al. 1998) or 567ms (Damian, Vigliocco & Levelt, 2001).

Also, researchers who have looked at the time course of naming processes have suggested that the time taken can provide indications of the *mental work* involved when a particular stage or cognitive system is being studied (Levelt et al., 1999; Salthouse, 1996). In contrast, several researchers have commented on the fact that naming processes in children have rarely used the reaction time paradigm (Cycowicz, Friedman & Rothstein, 1997; D'Amico, Devescovi & Bates, 2001; Johnson, 1992; Johnson et al., 1996; Roe, Jahn-Samilo, Juarez, Mickel, Royer & Bates, 2000).

3.3.2. Role of Information Processing Factors in Relation to Naming Speed

As mentioned earlier, a characteristic of children with language and reading disabilities is the slower latencies in naming speed, compared with typical peers (Denckla & Rudel, 1976 – investigating children with dyslexia; Catts et al., 2002 – investigating children with reading disabilities; Best, Dockrell & Braisby; Dockrell et al., 2001 – reporting slower latencies from children with WFDs; Lahey & Edwards, 1996a & b – examining children with SLI; Nation et al., 2001 – investigating poor comprehenders, and so on). In these investigations, there often appears to have been the assumption that the slower naming speed was caused by deficits in the language system. Interestingly, a converging body of evidence also revealed that children with language disabilities also exhibited slower response times to tasks involving non-lexical stimuli (e.g. pushing a button when a tone appears). Thus, there are two different explanations about the reasons for slow naming in some children. These are presented below.

3.3.2.1. Slower Processing Speed as Part of a Language Deficit

Children with Developmental Reading Difficulties

Children with dyslexia are slower on both discrete and serial naming (Denckla & Rudel, 1974; 1976; Snowling et al., 1988; Swan & Goswami, 1997). As already discussed, these children appear to have impaired phonological representations (see section 3.2.), and this has resulted in the suggestion that impaired phonological representations are the cause of slower naming speed. The implication thus seems to be that slower naming speed is specific to language based processes.

Nicolson & Fawcett (1995) assessed children with dyslexia (mean age of 8, 12, and 16 years) on a range of abilities such as rapid naming speed (e.g. discrete pictures, single letters, digits and colours), phonological skills (e.g. lexical decision), motor coordination (e.g. balance tasks or bead threading) or reaction time tasks (e.g. simple and choice motor). These researchers commented on the presence of *fundamental deficits* that involve naming speed as a potential source of these children's difficulties.

Wolf & Bowers (1999) have proposed a 'double deficit' model of developmental dyslexia. The authors used data from cross-sectional and longitudinal studies as a means of investigating the nature of the deficit. They have drawn attention to the presence of a particular (or specific) connection between serial naming speed and reading comprehension. Indeed, these authors argued that information processing as assessed by naming speed makes a separate and independent contribution to reading dysfunction. Wolf & Bowers' hypothesis stipulated that two sources of difficulties can be identified: dyslexia could be caused either by impaired phonological representations or by the presence of deficits in speed of processing. They suggested that the most severe forms of dyslexia are characterised by the presence of both deficits. In addition, they suggest that the speed of serial naming captures an important aspect of information processing speed and this ability is closely linked to the abilities involved in reading comprehension (Catts, 2002; Stringer & Stanovich; Wolf, Bowers & Biddle, 2000). A similar idea has been proposed by Catts et al. (2002) who suggested that speed of information processing could be seen as an "*extra phonological factor*" (p. 509) in populations of children with reading disabilities.

However, some children did not appear to exhibit such naming speed deficits (Ramus, 2003; Vukovic & Siegel, 2006). As a result, it is still unclear whether there is a specific naming speed deficit in all children with dyslexia.

Children with Language Impairments

There is also evidence that children with SLI name more slowly than typical peers (Sininger, Klatzky & Kirchner, 1989; Windsor & Hwang, 1999). Given that children with SLI have difficulties with language but not other areas of cognition, this has led to the suggestion that the slowness of children's naming might be because of their language impairment. However, the presence of a specific link between processing speed and language impairments has not been systematically investigated, despite some research highlighting such a link. For example, Miller et al. (2001) set out to investigate the possible *domain specificity* of processing speed. In their research, 8 to 9 year old children were assessed on a series of linguistic tasks (e.g. picture naming, judgment of rhyme or grammaticality) and non-linguistic tasks (e.g. simple motor or visual search/rotation). The authors found that the "*support for [the] generalized slowing [hypothesis] was weak*" (p. 427). Indeed, the general slowing hypothesis put forward by Kail (1991; 1994; 1999) claims that children's speed of response on a range of linguistic and non-linguistic tasks would decrease with age. In other words, a general mechanism was assumed to be responsible for changes in response times, regardless of the nature of the task at hand (i.e. language vs. non-language). However, in Miller et al. (2001), this general slowing across language and non-language tasks was not observed thereby suggesting that, for some groups of children, there seemed to be a "*problem [...] that was confined to language*" (p. 518). It is however possible that the lack of a general slowing in Miller's study either reflects the weak power of the study (with few conditions) or provides support for a reconsideration of the general mechanism underlying slower naming speeds (see next section for more detail).

A recent research investigation by Kail & Miller (2006) also has supported the notion of domain specificity in processing speed involving naming. The authors examined 9 and 14 year olds on both language and non-language tests. Their findings showed that the younger children were faster on language tasks, whereas the older children were faster on non-language tasks. The authors concluded that this provided a task specific account of processing speed (p.120) whereby "*processing speed within the language domain follows a unique developmental trajectory*" (p. 135).

There are similar suggestions about a specific connection between slower processing speed and language deficit from children with WFDs. A study by Dockrell et al. (2001; see also Dockrell et al., 2003) looked at 6:4 to 7:10 year olds' performance on naming tasks. Both accuracy and latency data were recorded. Findings indicated a common pattern where the language-impaired sample was significantly slower than typical peers on the naming tasks, but the children were not significantly slower when naming digits or letters. The implication is that speed of processing appears to be a specific problem of language with WFDs. Another finding that seems to support the idea of a specific relation between speed of processing and naming deficits comes from a recent paper by Dockrell & Messer (2006a). The authors conclude that the most compromised aspect of naming is the children's latency of response, whereas phonological processing skills appear to be unimpaired. As summarised by Dockrell and colleagues (2001; p. 279): "*children appear[ed] to have a specific problem in accessing representations*".

3.3.2.2. Slower Processing Speed as Part of a General Impairment

Observations that children with disabilities are slower, not only on naming tasks, but on a range of non-linguistic tasks tapping into speed of processing has challenged the assumption of specificity mentioned in the previous section. This possibility will now be discussed in relation to children with literacy and with language difficulties.

Children with Dyslexia or Reading Disabilities

In the field of developmental reading difficulties, a range of studies have indicated that these children are slower than typical children at processing information. For example, Catts et al. (2002) examined the role of speed of information processing in 8 to 9 year old children with dyslexia. Children were assessed on several reaction time tasks tapping into lexical (e.g. picture naming, grammaticality judgment, phonological judgment) and non-lexical stimuli (e.g. tapping, simple reaction time, visual search and mental rotation). Findings showed the presence of a generalised slowing across all tasks, regardless of whether the stimuli were lexical or not language-based (also see Manis, Doi & Bhada, 2000; Stringer & Stanovich, 2000; Wolf, Bowers & Biddle, 2000). The conclusions from these studies are consistent with the view that the speed of information processing influences a range of cognitive tasks (Kail & Hall, 1999; Kail, 1999).

Children with language Impairments

Some of the early work on children with SLI indicated that their speed of response on basic motor tasks (e.g. peg moving, tapping, beadthreading and so on) was slower than that of typical children. For example, Bishop & Edmundson (1987) found that 4-5 year old children with language impairments were significantly slower than typical age controls. These findings were replicated by Bishop (1990; 2001c) and similar conclusions were reached in that language impairments seemed to be linked with deficits in information processing speed (see Hill, 2001 for review of various studies). Similarly, Bishop (2002) compared children with SLI and typical controls on tasks involving minimal language processing – namely on a tapping and peg-moving task. The language-impaired sample was again identified as being significantly slower than typical peers. This led to the suggestion that deficits involving processing speed could be related to the severity of language impairments (Johnston & Ellis-Weismer, 1983 for slower speed on mental rotation; Sininger et al., 1989 for digit scanning; Montgomery & Leonard, 1998 and Windsor & Hwang, 1999 for auditory and visual detection). Bishop concluded that SLI might be caused by a *general cognitive limitation* in information processing capacity (Bishop, 1992). Although, it should be noted that a study of Lahey, Edwards & Munson (2001) reported no linear relationship between processing speed (naming, lexical decision or time taken to respond to non-lexical stimuli) and standardised scores on language assessments (Peabody vocabulary score).

A similar line of work by Kail and his colleagues (Kail & Leonard, 1986; Kail, 1991; 1994; Kail & Park, 1992) has resulted in the claim that children with language-impairments have a general slowing of performance across a range of tasks. Indeed, Kail was one of the first researchers to make the claim that a general deficit (or so-called *common global mechanism* – see Kail & Hall, 1999) in processing speed was responsible for children's naming deficits. Kail and colleagues conceptualised this as the *general information processing approach* (Kail, 1994; Kail, Hall & Caskey, 1999), where a "*global mechanism [...] that is [...] not specific to a particular task* –

might underlie developmental change in processing speed" (Kail & Miller, 2006; p. 119).

Through a series of experiments and meta-analyses of 72 studies Kail (1991) showed how children with SLI were significantly slower than typical children on a range of lexical and non-lexical tasks. Kail concluded that a general or non-specific mechanism (i.e. a mechanism that is not dependent on a particular area of cognition) underlies changes in processing speed (Kail & Hall, 1994; 1999; Kail, et al., 1999; Kail, 2000). A further study by Kail (1994) examined 6 to 13 year old children with SLI on picture naming, picture matching and memory scanning. These findings also revealed that the SLI sample was generally slower than the typical age matches on all tasks and these children were slower by a constant proportion. Further confirmation of this assumption was obtained when examining the performance of 7 to 13 year olds on a range of naming, reading, comprehension and non-linguistic tasks (Kail et al., 1999).

Other research has supported Kail's hypothesis in that children with SLI have a general slower response time than typical children. For example, Lahey & Edwards (1996) examined a wider age range of children (4 to 9:5 year olds) with SLI on naming tasks. Their findings supported the notion of a general deficit upon observing that the speed of naming of children with SLI was significantly slower than their typical peers. In addition, speed of naming was also related to slower non-linguistic response times. Windsor & Hwang (1999) set out to 'test' Kail's general slowing hypothesis with children with SLI. The authors used children from several studies (Lahey & Edwards, 1996; Windsor, 1997 and Windsor & Hwang, 1999) so as to obtain a wide range of data. Children (age range of 4:0 to 9:8 and 10:0 to 12:6) were assessed on reaction time tasks involving lexical stimuli (e.g. picture naming, lexical decision etc) or non-lexical stimuli (e.g. pressing a key when a sound is heard or to discriminate between sounds etc.). Findings indeed confirmed a general slowing of the SLI sample's latencies on all 10 reaction time tasks. As Leonard (1998) summarised in a review of SLI, a growing body of evidence has shown that the *specific* linguistic impairment of children with SLI might not be specific at all as these children manifested problems in areas of cognitive functioning that did not involve language.

In Summary: Language and literacy difficulties have usually been explained in terms of a semantic and phonological impairment. However, and as Kail & Salthouse claimed (1994; p. 201), speed ought to be considered as a "*fundamental part of the architecture of the cognitive system*". As a result, investigations of naming processes ought to examine speed of information processing along with semantics and phonology.

The issue as to whether non-lexical deficits cause, or are merely correlated with, language disabilities remains open to debate (Miller et al., 2001; Ramus et al., 2003b; Rice, Wexler & Cleave, 1995). An important point to consider is that this issue has rarely been addressed in research on typical children. Therefore, of particular interest to the current thesis is how this aspect of cognition relates to typical development, an issue thereby addressed in the first chapters of the thesis.

IV. Aims of Research and Structure of Thesis

The preceding sections highlight the complexity of the naming process and the necessity of considering the role of cognitive factors such semantic and phonological representations, as well as the role of speed in relation to the naming process. An implication of the studies investigating populations of children with language disabilities is that reaction time data can provide useful information about the processing of lexical information and therefore, ought to be taken into consideration when studying naming processes of typical development. In addition, although the focus of the current thesis is not on children with language disabilities, a better understanding of how typical naming proceeds (by using research and methods from the atypical studies mentioned in the previous sections) can provide additional insight into lexical access and naming.

The focal point of the current thesis concerns two types of lexical processes (namely picture naming and word learning) and the types of representations involved in these processes. As a result, the thesis has two main themes. A first part focuses on the process of lexical access and word production (involved in picture naming) and the second part of the thesis builds on this research when considering word learning and lexical access (using assessments of lexical representations from the first set of investigations).

Chapters II to V focus on the naming process in a range of typical children spanning the 6 to 11 age range. The aim was to build on previous work on atypical children in order to provide a more comprehensive picture of the way that cognitive abilities are related to the naming process. The investigations presented in this thesis assessed a range of cognitive abilities believed to tap into different aspects of the naming operation. The choice of the assessments was in part influenced by previous research on naming in atypical samples. Findings will be presented about assessments of semantic, phonological and non-lexical speed of response in relation to the way speed and accuracy of naming. The methods of investigation will be described in Chapter II. Chapter III will address issues concerning the variables that predict the speed of response and the variables that predict naming accuracy will be the focus of Chapter IV - both chapters will be concerned with discrete and serial naming. Chapter V considers the types of errors that occur when naming and the relation of lexical characteristics to these errors. During the research process, there was an opportunity to compare the performance of typical children with those who have WFDs and this sample is included in Chapter V.

At this point it is worth noting that the second part of the thesis focuses on the processes of word learning in typical children. A literature review of this topic is provided in Chapter VI. Following this, two studies investigate the acquisition of new lexical representations. The studies involve a comparison of the facilitatory effects of semantic or phonological information on word learning. A range of tasks are used to investigate whether learning took place. Similar to the investigations of naming, the investigations of word learning chapters (Chapters VI to VIII) assess both the content of the lexicon (exemplified by accuracy scores on several lexical dimensions) and the efficiency of lexical processes (exemplified by the speed of response in accessing this information).

To summarise, as discussed earlier, there has been considerable interest in the operations involved in lexical processes such as naming or word learning. Nevertheless, previous studies usually have been limited to looking at one or two processing factors in isolation, thus little is known about the types and range of cognitive abilities that enable children to name quickly and accurately. As a result, there is a need to understand the way that different sorts of cognitive abilities are related to naming and how they subsequently influence lexical access. Gaining a better understanding of naming processes is important both to understanding this basic cognitive process in typical children and in the longer term, to help understand the development of children with naming or learning disabilities.

CHAPTER II

NAMING IN TYPICAL CHILDREN: METHODS AND DESCRIPTION OF ASSESSMENTS

I. INTRODUCTION

This chapter concerns children's naming ability. Naming is typically a fast and accurate process that takes place on a daily basis (Levelt et al., 1999). However, despite proceeding with relative ease, research has shown that this multicomponential process involves complex operations (Goodglass, 1980; 1998; Jolicoeur et al. 1984). The current research was set up to understand more about the nature of the naming process and the lexical representations involved in naming in relation to typical development.

Research into naming has generated a lot of interest over the years, especially in relation to populations of adults and children with language disabilities (d'Amico et al., 2001; Levelt et al., 1999; Newman & German, 2002; 2004). The importance of naming stems from findings showing how children with language disabilities exhibit slower naming latencies but also tend to be less accurate. Such naming 'failures' are observed in different populations of children, such as children with dyslexia (Catts et al., 2002; Nicolson & Fawcett, 1994), children with Specific Language Impairment (Lahey & Edwards, 1996) or children with Word Finding Difficulties (Kail & Salthouse, 1994). It has also been observed that naming difficulties are concomitant with impairments in other related areas of development such as academic achievement, communicative and socio-emotional behaviour and so on (Terrace, 1985; Bashir & Scavuzzo, 1992; Wallach & Butler, 1984).

CHAPTER II: Methods and Description of Assessments

1.1. Rationale for Current Research and Choice of Tasks

As claimed by d'Amico et al. (2001; see also Johnson et al., 1996), there is a lack of research investigating naming and the different stages of the naming process in typical development. One approach (stemming from work on adults) has been to investigate the effects of lexical characteristics (such as word frequency, age of acquisition, imageability and so on) on the time taken to name pictures (Bonin, Chalard, Meot & Fayol, 2002). Another approach was to compare language-impaired samples with typical peers. Although informative, this nevertheless fails to provide insight into the mechanisms underlying the naming process. In addition, previous work has rarely provided a comprehensive picture of the naming process. Consequently, the current research was designed to provide insight into the nature of typical naming processes and the lexical representations underlying children's ability to name quickly and accurately. It was decided to build on the methods and findings of previous work on atypical populations. This chapter focuses on the methodology used, as well as the rationale for the choice of tasks. Issues concerning the findings about the speed (see Chapter III) and accuracy (see Chapter IV) of naming will be presented in the following chapters.

The reaction time paradigm will be used as a novel way to investigate typical naming processes. As summarised by Levelt et al. (1999), analysis of latency data is a necessary addition to existing methodology as it provides "*an ideal procedure for analysing the time course of a mental process*". However, latency data about the speed of naming and other related (cognitive) abilities has rarely been investigated to the study of children's naming (d'Amico et al., 2001; but see chapter I for studies of latency). Despite this, response times are believed to provide useful information about the processing of lexical information regarding the mental work involved (Salthouse, 1996). In order to expand the field of research, it was decided not only to measure the time taken to name pictures, but also to assess the speed and accuracy of response on a range of tasks believed to be involved in the naming process. The following sections will present the main categories of tasks used (i.e. semantic, phonological and non-lexical speed of processing) and the rationale underlying the selection of tasks.

In previous studies, children's naming usually has been assessed either by discrete naming tasks when children name one picture at a time, or serial naming when a series of items that are printed on one page are named. The discrete format is commonly used with language-impaired children (Dockrell et al., 2003), whereas the serial format has been used with children with literacy impairments (Wolf & Bowers, 1999). Despite these two tasks having been extensively used; few studies have examined the relationship between these two naming procedures, and whether they involve similar or distinct processes. This is particularly unclear in typical development (e.g. Bowers & Wolf, 1993; Berninger, Abbott & Alsdorf, 1997). It was therefore decided to use both these tasks to assess naming, examine the relationship between children's performance (namely speed of response) on serial and discrete naming, and examine the relation between other assessments of lexical processes and these two forms of naming.

As mentioned in Chapter I, a range of lexical and non-lexical processes (Kosslyn & Chabris, 1990; Goodglass, 1980; Lahey & Edwards, 1996) can help us to understand lexical retrieval. Particularly important are processes involving semantics, phonology and speed of information processing. The following sections present an overview of the measures of these processes.

1.2. Lexical Representations – Semantics and Phonology

Lexical representations involve phonological and semantic representations (Laine & Martin, 1996; Levelt et al., 1999; Schwartz et al., 2006). This provided a rationale to use the British Picture Vocabulary Scale (Dunn et al., 1992) to assess the size of the children's receptive vocabulary. The other tasks were designed to assess either phonological or semantic abilities.

The rationale for using measures of *phonological ability* stems from work on children with literacy disabilities. Difficulties with the processing, or the storage, of phonological information is believed to be the cause of these children's poor performance on decoding and naming tasks (Snowling, 2000; Swan & Goswami, 1997a; Wolf & Bowers, 1999). There are several ways to assess phonological representations, and different tasks are believed to tap into different levels of phonological processing (Cain, Oakhill & Bryant, 2000). One of the tasks widely found to be associated with early literacy abilities involves phonological awareness. This involves assessing children's ability to compare or discriminate between spoken words by picking the 'odd-one-out' on the basis of their phonological (or sound) structure (Martin & Saffran, 2002). It was thus decided to use the *Alliteration* and *Rhyme* sub–tests from the Phonological Assessment Battery (PhAB; Frederickson, Frith & Reason, 1997). In addition, because the integrity of phonological representations has been put forward as a cause of the naming problems of children with dyslexia (Swan & Goswami, 1997a & b) it was decided to employ an *Auditory Lexical Decision* task where children have to identify whether or not the sound they hear is a word.

S*emantic representations* and abilities are also believed to influence successful word retrieval, with much of this work having been conducted on children with disabilities (Kail & Leonard, 1986; Bjorklund & Schneider, 1996; Dockrell et al., 2003; Nation et al., 2001). However, there is a difficulty in assessing semantic ability as few standardised measures are available to date. Moreover, assessments of children's semantic ability are most often limited to measures of vocabulary size and/or children's comprehension skills - where children were required to choose the target name among a set of distractors (Miller, 1999).

Semantic representations are typically organised according to specific relations (Rosch, 1975). The notion of a semantic hierarchical network (Collins & Quillian, 1969; Tulving, 1972) emphasises the fact that relationships between words (or concepts) are linked by associations that differ in strength and type (Anderson, 1990). Because of the uncertainty in assessing semantic abilities, it was decided to use a range of measures. Two offline tasks were used to assess semantic abilities. Children's ability to retrieve related semantic items was assessed by a sub-test of the PhAB – namely the *Semantic Fluency* test, which involved naming as many items as possible that are related to a target word. A *Verbal Definition* test was also used. The target words chosen for this experimental task were taken from the Brtish Ability Scales (BAS-II; Elliott, Smith & McCulloch, 1996) and the Expressive One-Word Picture Vocabulary Test (EOWPVT-R; Gardner, 1990). These assessments are believed to capture children's knowledge of word meanings (i.e. notion of semantic relatedness).

Two other tasks which assessed online processing were employed. One of these was a semantic category verification (or categorisation) task, whereby the target pictures were either typical or atypical examples of categories. This task taps into classification and sorting, and requires children to possess knowledge of the relationship between concepts and categories (i.e. *semantic distance*, see Rips & Shoben, 1973). Another experimental task, a semantic *odd-one-out* task was also used as a new approach to the investigation of semantic relations. This assessment required children to make judgments about which 2 of 3 items best belonged together (details are presented in a subsequent section).

An important distinction in relation to semantic ability concerns the difference between *online* and *offline* methodologies. *Online* tasks tap into real-time, ongoing (or immediate) processes and are believed to place minimal metacognitive demands on children (Kempler, Almor, Tyler, Andersen & MacDonald, 1998). *Offline* assessments require metacognitive monitoring processes, where children need to reflect upon their own cognitions (Flavell, 1979; Nelson & Narens, 1996). This typically involves an additional element of thinking and/or planning (which are thereby affected by memory or attentional demands – e.g. Shapiro, Swinney & Borsky, 1998). As a departure from previous work, both of these methodologies have been included so as provide a wider range of information as to what is happening in typical naming.

1.3. Non-Lexical Representations – Speed of Information Processing

In order to clarify the nature of the relationship between the underlying speed of information processing and lexical abilities, speed of response on non-lexical tasks was also investigated. Non-lexical tasks are not equal in difficulty and according to the type of task, place varying cognitive demands on children. In order to gain an understanding into the determinants of naming, it was decided to use several tasks to assess non-lexical speed of response.

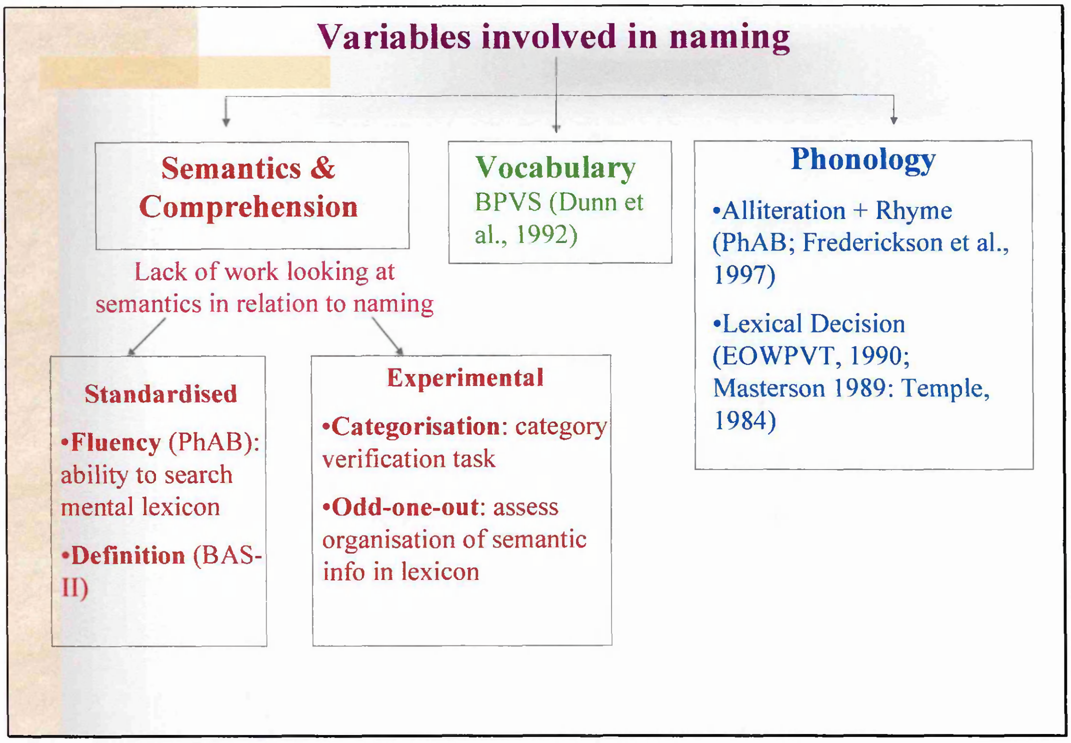
Three assessments were chosen. One was a counter pressing task which consisted in clicking a lever (or counter) as often as possible for 20 seconds. The rationale for using this task stems from work on language-impaired populations (see Hill, 2001 for review) where researchers have found that rapid movements involving fingers (Bishop & Edmundson, 1987; Johnston, Stark, Mellits & Tallal, 1981) or pressing a button repetitively (Hughes & Sussman, 1983; Preis, Schittler & Lenard, 1997) were slower in children with language impairments, compared to typical peers. Similar reports are available from populations of children with language or reading disabilities (Catts et al., 2002; Miller et al., 2001; Wolf, Bowers & Biddle, 2000).

Another type of task that is often used to assess speed of processing is the response time in detecting a visual stimulus (Miller & Kail, 2006). There is evidence that simple and choice reaction time tasks assess different cognitive processes. Nicolson & Fawcett (1994), studying a population of dyslexic children, found that deficits in the speed of processing were more likely to occur in choice, rather than more simple response time tasks (i.e. at the most basic level of perceptual detection). The difference was attributed to the more complex demands of this task (Wolf et al., 2000) – namely the additional demands of making a choice (Frearson & Eysenck, 1986). As a result, it was decided to employ both simple and choice reaction time tasks.

1.4. In Summary

The current investigation builds on the existing literature about atypical children so as to provide a picture of typical children's cognitive-linguistic abilities that could be related to naming (Figure 1 below illustrates the range of tasks used in the current investigation of typical naming processes). The current methodology will therefore use two sources of information: the accuracy of children's response (i.e. lexical knowledge) and the speed with which children access this information (i.e. lexical efficiency) on a range of measures involving language and non-lexical stimuli. These measures are summarised in Figure 1. In Chapter III analyses are conducted to determine which of these assessments of lexical abilities is related to the speed of naming (both serial and discrete). In Chapter IV analyses are conducted to determine which of these assessments is related to the accuracy of naming. Together these analyses aim to provide a better understanding the way that the cognitive system underpins and supports efficient lexical retrieval.

Figure 1: Overview of the tasks used in the investigation of typical naming processes



II. METHODOLOGY

2.1. Participants

Data was collected from 105 children in 3 age groups. Children were recruited from mainstream schools in the area of South-East London. Testing took place in a quiet environment, on the school premises.

Table 1: Summary of participants' characteristics across the three age groups

	Year 2 (6-7 year olds)	Year 4 (8-9 year olds)	Year 6 (10-11 year olds)
Total	N = 35	N = 35	N = 35
Gender	20 boys, 15 girls	21 boys, 14 girls	11 boys, 24 girls
Age range	[5:11 – 7:06]	[8:09-9:08]	[10:05-11:06]
Average age	6:02	9:06	10:02

2.2. Overview of Assessments used in Study

Table 2: Summary of the tasks used to assess lexical abilities

Session 1	<u>Computer tasks</u> 1) Counter pressing task 2) Picture naming 3) Simple motor 4) Auditory Lexical decision 5) Choice motor 6) Categorisation	20 minutes per child
Session 2	<u>Standardised and experimental tasks</u> 1) Verbal Definition 2) Phonological awareness 4) Semantic fluency 5) R.A.N. 6) Semantic odd-one-out	30 minutes per child

As illustrated by Table 2, tasks were administered in two sessions so as to not to place undue demands on children or staff. The experimental tasks involving a computer were administered in a first session, whereas the standardised measures and other tasks were used in a second session. Tasks were presented in the same order for all children, on a one-to-one basis.

2.3. Material and Procedure

The four types of tasks (i.e. naming measures, measures of phonological ability, measures of semantic ability and measures of non-lexical speed) are presented below in separate sections. Each section contains description of materials, procedure and details of data recording and data reduction. In addition, where appropriate, details of inter-correlations between the test items (for each of the task) were presented. In all cases, in order to reduce the number of variables, it was decided to use a summary statistic for each of the assessments described below. This consisted of a mean response time for the latency data and a total accuracy score.

2.3.1. Measures of Lexical Ability – Naming Tasks

2.3.1.1. Discrete (or Confrontational) Naming: Picture Naming

Material: Thirty black and white pictures were selected from the Expressive One-Word Picture Vocabulary Test (EOWPVT-R which has 100 pictures; Gardner, 1990), which is a standardised test typically administered to 3:6 to 11:11 year old children. Pictures were selected so as to tap into a range of difficulty levels (pictures were graded according to the standardisation norms). Appendix A provides details of the thirty items selected. Most items were pictures of a single referent, but some were designed to produce a superordinate level of response e.g. "*fruit*", "*furniture*", "*animals*". Pictures were scanned and programmed via the SuperLab-pro software so that they would appear, one at a time, on a central location on a computer screen.

Procedure: Pictures appeared on the screen, one at a time and in a random order for each child. Children were instructed as follows: "*Look at the screen. You are going to see some pictures one at a time. Tell me the name of the object / thing in the picture. Try to name them as quickly as you can, but without making mistakes. Do you understand what you have to do? Are you ready?*" The start and end of each session were signalled both by a visual display on the screen and by verbal instruction. Before presentation of the test items, 4 practice trials were given so as to ensure children properly understood what was required.

Data recording and reduction: Both accuracy and speed of response (consisting in the time from stimulus onset to the onset of children's oral response) were recorded by the experimenter pressing a colour coded key on the laptop. A red coloured dot represented an accurate response, whereas a green coloured dot represented an incorrect response. Both keys were next to each other so as to facilitate ease of response.

Latency: As suggested by previous work (see Catts et al., 2002; Lahey & Edwards, 1996), latency analysis was based on correct responses for all the measures in this study. Following common practice, outliers were excluded from the data set although perusal of the literature indicated a lack of consensus regarding the selection of an objective criterion (Cycowicz et al., 1997; Lahey & Edwards, 1996a & b; Weiler, Forbes & Kirkwood, 2003). In the current investigation, it was decided to use the criteria of 2SD to identify outliers as this is believed to be more representative of the normal spread/distribution of children's reaction times (cf. Fazio, 1990; Hanson & Montgomery, 2002. This criterion has also been used in several recent investigations of children's naming processes (Fazio, 1990; Hanson & Montgomery, 2002; Truman & Hennessey, 2006). Therefore, for all the data from this study, outliers were considered to be responses involving a latency that was 2 standard deviations from the average mean of the age group. Outliers were subsequently replaced by the means for the specific item from the age group under consideration. To obtain a summary statistic, it was decided to obtain the mean response time to the thirty pictures used to assess discrete naming for each child. Inspection of the inter-correlations between the thirty items on the picture naming task showed that twenty-three percent of the correlations were significant with 52% of the correlations $\geq .30$.

Accuracy: Deriving a summary measure of accuracy was relatively straightforward. As with other studies (see Dockrell et al. 2001), accuracy consisted in the total number of items correctly answered (see Appendix B for percentage accuracy for each of the 30 items of the discrete naming task). For a response to be coded as correct, children had to pronounce the word at it is conventionally known (i.e. 100% accurate).

2.3.1.2. Measure of Serial (or Continuous) Naming: R.A.N.

Material: The Rapid Automatized Naming task was used to assess serial naming (RAN; Denckla & Rudel, 1974). The task consisted in the presentation of 50 symbols (a set of 5 items presented serially and repeated 10 times) on one A4 laminated card. All 4 subsets of the RAN – i.e. letters (p, o, d, a, s), colours (red, blue, green, yellow, black), numbers (2, 6, 9, 4, 7 and objects* (umbrella, comb, scissors, watch, key), were administered.

Procedure: The order of presentation of the subtests was counterbalanced across children, who were instructed as follows: "*You are going to name some things you see as fast as you can, without making mistakes. First, tell me the names of each of these (practice trial for each of the 4 subsets). Good. Now, when I say "Go", name every single thing you can see across this row (sweep finger across top row) and this row (sweep finger across second row) and so on, until you come to the very last one on the page (sweep finger across whole set). Ok? Don't stop until you get to the end. Are you ready? Go!* " Practice trials preceded the administration of the test items so as to ensure children understood what they had to do.

Data recording and reduction: The total time taken by a child to name the set of 50 symbols was recorded via a stopwatch, for each of the subtests. Speed of response consisted in the time from stimulus onset to the end of children's response (i.e. once they reached the 50th stimulus). This total time was divided by 50 so as to provide a mean response time for an individual item, and also to enable comparison with the discrete picture naming latencies. As before, outliers were replaced by the means for the age group under consideration.

* Picture of objects taken from the Stanford-Binet Test, form L.

Table 3: Degree of association between latency measures on 4 subtests of the RAN

	RAN Letter	RAN Colour	RAN Object	RAN Number
RAN [Letter]				
Pearson correlations (N = 105)	---	.726**	.745**	.771**
Sig. (2-tailed)		.000	.000	.000
RAN [Colour]				
Pearson correlations (N = 105)		---	.698**	.699**
Sig. (2-tailed)			.000	.000
RAN [Object]				
Pearson correlations (N = 105)			---	.593**
Sig. (2-tailed)				.000
RAN [Number]				
Pearson correlations (N = 105)				---
Sig. (2-tailed)				

****Correlations significant at the .01 level (2-tailed)**
***Correlations significant at the .05 level (2-tailed)**

All four subsets of the RAN were significantly correlated with one another (with an average of r = .71). In order to reduce the number of variables in the study, it was decided to use a combined mean on the 4 subtests of the RAN.

2.3.2. Measures of Phonological Ability

2.3.2.1. Auditory Lexical Decision

Material: This experimental task was devised to assess children's ability to discriminate between words and nonwords. A set of 20 words was chosen from the EOWPVT-R (Gardner, 1990). Items were chosen so that they tapped into graded levels of difficulty (according to age on the standardised test – see Appendix C for list of items). The 20 nonwords were selected from standardised lists of items from Temple (1984) and Masterson (1989). The task was set up by use of the SuperLab-Pro software for Windows. Headphones were used to listen to the words. Children were instructed to press one of two keys [C and M – both marked by yellow coloured dots] to discriminate between words and nonwords [press "C" for a word, press "M" for a nonword]. The keys were not far apart, and on the same row, for ease of response and children had to use both hands. The presentation of items was randomised for each child. The inter-stimulus interval varied between 1 and 4 seconds. The task consisted of 6 practice trials (3 for real words and 3 for nonsense words) and 20 test items.

Procedure: Children were introduced to the task as follows: "*You will hear someone speak. The voice will say something and you have to decide whether what you hear is a word or whether it is a nonsense word/not a real word (experimenter ensures children know the difference). If what you hear is a word, you need to press this key (C), but if what you hear is not a word; you press this other key (M). So, keep both hands like this (experimenter demonstrates), but don't press until the person has finished speaking. Listen carefully, because you can only hear the things once. Remember, try to be as quick as you can but without making mistakes. Ready? Let's go.*" The start and end of the task were signalled by a visual display on screen as well as by verbal instruction. Prior to the testing session, 6 practice trials (3 words and 3 nonwords) were given to ensure children understood the task.

Data recording and reduction: Both latency in milliseconds (duration between stimulus onset and onset of child's response) and accuracy of response were automatically recorded by the software. **Latency**: As before, latency analysis was based on correct responses only. Outliers were identified and replaced by the means. Twenty percent of the correlations between the different items were significant (with 56% of the correlations $\geq .30$). Subsequent statistical analyses used the mean response time obtained on the 40 items for each child, as a summary statistic. **Accuracy**: Accuracy of response consisted in the total number of correct responses on words and nonwords.

2.3.2.2. Phonological Awareness

Material: Two subtests from the Phonological Assessment Battery (PhAB; Frederickson, Frith & Reason, 1997) were used as a measure of children's phonological awareness: these were the Alliteration (10 items) and Rhyme (21 items) subtests.

Procedure: Children were instructed to pick two (out of three) words presented orally that shared the same sound at the beginning (Alliteration) or at the end (Rhyme). The assessments were administered according to the procedure given in the PhAB manual.

Data recording and reduction: The correlation between scores on the *alliteration* and *rhyme* tests was high ($r = .649$; $p = .000$), thereby suggesting both tasks measured a similar ability. In order to help reduce the number of variables, it was decided to use the mean score (i.e. mean number of items correct) for this measure of phonological awareness. Standardised scores were also obtained (by using the norms from the test manual).

2.3.3. Measures of Semantic Ability

2.3.3.1. Definition

Material: The task was administered to examine whether children could retrieve the correct meanings of the target words. Test items were chosen from 2 standardised sources: four words (*computer*, *tractor*, *lamb* and *stool*) were selected from the EOWPVT-R (Gardner, 1990). These words were taken from the earlier age ranges i.e. 3:6 to 7:11 according to the norms of the test. Three other words were taken from the British Ability Scales (BAS-II; Elliott, 1996) – namely *scissors*, *bed* and *tiny*. Again, these were items at the earlier ages i.e. 5:0 to 7:11(the BAS-II included items up to 10:11 years). In both instances, it was decided to select words so as not to be too difficult for the younger children that were part of the current investigation (i.e. the Year 2 age range).

Procedure: Children were instructed as follows: "*Now let us see how many words you know. I will say a word and you have to tell me what the word means. Do you understand what you have to do?*" In case of non-responses, probes were used to encourage children to provide further elements of response *e.g. "Can you think of anything?*"

Data recording and reduction: Children's response time was recorded by a stopwatch (from onset of saying the target word to the end of children's utterances). As before, analyses were carried out on correct responses only and outliers were replaced by the means for the specific word from the age group under consideration. Ninety percent of the correlations between the latencies of the individual items were significant, with 85% of the correlations $\geq .30$. The mean response time to the 7 words was used in subsequent data analysis. Accuracy measures consisted of the total number of correct elements of response. Furthermore, the type of response was also examined by use of a coding frame, which is presented below.

Table 4: Coding grid for verbal definition task

Eight main categories of responses were used so as to capture the full range of children's answers. Multiple coding was allowed so that children's responses could comprise more than one category, as well as more than one attribute from each category.

CATEGORIES	DEFINITION
Semantic	Types of responses giving an indication of the relationship between the target and either the general category (i.e. superordinate levels of association such as: "What is a lamb?" *It is an animal*; "What is a tractor?" *It is a vehicle*) or associated concepts (i.e. "What is a lamb?" *It is a type of sheep*; "What is a tractor?" *It is like a car.*

Functional	Types of responses giving information as to the relevance of the object in terms of its uses, what it does and/or how people use it – e.g. "What is stool?" *You sit on it*; "What are scissors?" *You cut stuff with it.*
Locative	Types of responses which provide information as to where one might find the object and/or where one might typically use the item – e.g. "What is a computer?" *People use in offices*; "What is a tractor?" *It lives on a farm.*
Thematic association	Types of responses where children use contextual information to name an object that is associated with the target, or give related information – e.g. "What is a tractor?" *Driver*; "What is a bed?" *It means when you are tired, you can sleep on it.... Something you sleep in at night, like if you want to rest somewhere quiet and there's no one in your room, you can lay in your bed.*
Properties	Types of responses which describe the target's physical characteristics and/or inherent properties or components – e.g. "What is a computer?" *It's got keys...It's powered*; "What is a tractor?" *It makes noise... Engine.*
Don't know	Types of responses where children either gave no answer, or admitted they did not know (or forgot) the meaning of the target – e.g. *I don't know, I can't remember.*
Recursive	Types of responses where children reiterate the name of the label children without any attempt to explain or define the word – e.g. "What does tiny mean?" *You are very tiny* or *Like something is tiny.*
Other	Types of responses that do not fit in any of the previously defined categories and usually comprise non-related and/or incoherent types of responses – e.g. "What is a computer?" *Information... Like a library, but you need to walk there, put your shoes on, you can go in classroom to computer.*

2.3.3.2. Semantic Fluency

Material: The fluency task was taken from the Phonological Assessment Battery (PhAB; Frederickson, Frith & Reason, 1997). This standardised task was used to measure children's ability to search their mental lexicon rapidly and automatically by looking for relations between objects. Children had to say aloud, in the space of 30 seconds, as many words as they could think of, belonging to a stated semantic category. There were 3 categories: *things to eat*, *animals*, and *objects at school.*

Procedure: The instruction went as follows: "*I'm going to ask you to tell me as many words as you can in a short time. When I say "Go!" tell me all the things there are in your school. Tell me as many things as you can think of before I say "Stop". Remember to tell me things in your school. Are you ready? Go!*" (The instruction remained the same for the other two categories).

Data recording and reduction: A child's fluency score was the total number of correct responses. Standardised scores were also calculated via use of the test manual.

2.3.3.3. Semantic Categorisation

Material: A category verification task assessed children's knowledge of semantic class and category membership. Children saw pictures, one at a time, on the centre of the screen and had to make a judgement as to whether a given picture belonged to a stated category. Target pictures were either typical or atypical examples of animate or inanimate categories. Six categories were used: 4 general categories - *animal* (8 items), *bird* (8 items), *fruit* (8 items), *vehicle* (8 items) and 3 specific categories - *lamb* (6 items) and *stool* (6 items). The categories were presented in a fixed order but the order of presentation of items within a category was random. Children saw a total of 44 pictures on the screen (see Appendix D for list of items and details of coding). The task was programmed via the SuperLab-Pro software for Windows.

A range of items were selected where some items were central to the category or shared many similar characteristics (e.g. showing an apple for the category *Fruit*); other items were less representative of the category (e.g. showing a pineapple for the category *Fruit*); yet other items were unrelated (e.g. showing the picture of a butterfly or a carrot for the category *Fruit*).

In order to distinguish between typicality of items, the norms of Battig & Montague (1969) were used. Adults were also asked to judge whether the specific pictures were representative of each stated category or not (central vs. peripheral distinction), and to what extent. There was 100% agreement on the category "animal"; 83% on category "bird"; 92% on "fruit" and 92% agreement on "vehicle" - which resulted in an overall of 92% agreement.

Procedure: Children were introduced to the task as follows: "*Look at the screen. You will see pictures appear, one at a time. Say "yes" if the picture that you see is an animal; say "no" if it is* <u>*not*</u> *an animal* (instruction changes according to category). *Try to be as quick as you can, but without making mistakes. Ready?*" The start and end of each session was signalled by a visual display on the computer screen and by verbal instruction.

Data recording and reduction: Accuracy and speed of response in milliseconds (time from stimulus onset to onset of children's response) were recorded by the experimenter pressing a colour coded key on the keyboard. A red coloured key represented an accurate response, whereas a green coloured key represented an incorrect response. Both keys were next to each other to facilitate ease of response. **Latency**: Latency of response consisted in the time taken by children to judge whether the pictorial stimuli belonged to each specific category. As carried out previously, outliers were excluded from the data set and analyses were conducted on correct responses only. Twenty-six percent of the correlations between test items were significantly correlated (with 43% of the correlations $\geq .30$). The mean response time on the 44 items was calculated for each child and represented the summary statistic that was subsequently used in ensuing statistical analyses. **Accuracy**: Accuracy consisted in the total number of correct responses for all test items (i.e. with out of a total of 44).

2.3.3.4. Semantic Odd-one-out

Material: This task was specifically designed for this study. It involved presenting 12 sets of three pictures (each set on a laminated A4 card). Two of the 3 pictures were of the same object, albeit as visually distinct as possible; or 2 of the 3 pictures were very strongly related. The pictures selected for this task were taken from the EOWPVT standardised assessment – e.g. computer, ostrich, tractor, lamb, stool, spanner (see Appendix E for list of items). Thus, for example a child saw a plate with 3 pictures (lamb – ostrich – computer) and was asked to select the odd-one-out. The position of the pictures across the plates was randomised for each of the 12 sets.

Procedure: Children were instructed to make a comparative judgement and select the object that was different from the others, as follows: "*Now I'm going to show you 3 pictures at a time. Look at them carefully and then tell me which one doesn't go with the rest. And why do you think this one is different from the other pictures? Try to be as quick as you can. Are you ready? Go!*"

Data recording and reduction: **Latency**. Response times were recorded via a stopwatch from the onset of the presentation of each set to the onset of a child's response. Outliers were replaced by the means. Sixty-four percent of the correlations between test items were significant (with 44% of the correlations $\geq .30$). In subsequent analyses, the mean response time was used as the summary statistic for this assessment. **Accuracy**: Accuracy consisted in the total number of correct responses. A coding grid was used to categorise the types of responses children made. Three main categories were used: *unrelated*, *perceptual* and *semantic*. In order to capture the full range of children's answers, responses were coded into one of the 4 categories described in Table 5 below.

Table 5: Coding grid for the semantic odd-one-out task

CATEGORIES	DEFINITION
Functional	Types of response which describe the use/purpose of the item, what it does and/or how people use it. This category comprises elements of responses that would answer the following questions: "Who uses it", "How is it used", "What is it for etc. Examples of children's response are as follows: "*You see through*" (binoculars), "*You can type*" (computer) and so on.
Properties	Types of responses describing the item's physical/perceptual characteristics, components or inherent composition. Items pertaining to this category answer the following questions: "What is it like", "What is it" etc. Illustration of these types of responses includes: "*It works with electricity*", "*It has got internet*", "*You use it with a mouse*" (computer). Examples of inadequate responses: "*It has a man on top*" (bulldozer).
Semantic	Types of responses giving information pertaining to the semantic category of the object. Distinctions are made according to the nature of the relationship with the target word – namely relationships include superordinate, coordinate, examplar and thematic levels of association. Items pertaining to this category answer the following questions: "What kind of thing is it", "What group does it belong to", "What is it an example of" etc.
Other	Types of responses where children provide no rational argument for choosing the odd-one-out. One of three options typified these types of answers: (a) types of responses that do not bring any information/no attempt at specificity and/or using the property of an object to state a point of difference (e.g. Computer – "*Because it's a computer*"; Animal – "*Because it has legs and ears*"; *Tractor – "Because it has wheels"*); (b) no coherent answer or part of the answer is correct and/or has characteristics of the set of 3 pictures (e.g. "*It's an animal and it's got an engine*", "*Because this one's (spanner) for metal things, (stool) is for sitting and this one's (lamb) an animal*") (c) don't know types of responses.

Children often produced several explanations. Therefore, multiple coding was allowed. Accuracy scores thus consisted in the total number of correct responses.

2.3.3.5. Receptive Vocabulary

The British Picture Vocabulary Scale (BPVS-II; Dunn et al., 1992) was used as a measure of children's receptive vocabulary. Children were asked to choose the appropriate target among a set of 4 pictures by pointing to the relevant target. Administration of the task was terminated when children made 8 mistakes in a row. A raw score was calculated and was subsequently converted into a standardised score using the test manual. Children with standardised scores below 85 were not used in subsequent data analysis, to ensure all children had 'typical' language abilities.

2.3.4. Reaction Times to Non-Lexical Stimuli

2.3.4.1. Repetitive Pressing of Counter with Thumb

Material: The task consisted in having children hold a small object (clicker) in their hand and press the small lever as many times as they could in the space of 20 seconds. As children pressed the button/lever with their thumb, a counter recorded the number of finger presses. The higher numbers of clicks reflect a faster speed of response.

Procedure: Children were instructed as follows: *"Now let's play another game. Take this in your hand and press this button like this (demonstration). When I say "start" press this and go on clicking until I say: "stop"... Ok? Don't stop until I say "Stop?"* (Experimenter ensures child holds object properly). *Don't forget, you have to press as many times as you can until I say: "stop". Are you ready? Go!*" This task was carried out with both hands. The start and end of the task were signalled verbally by the experimenter, who also gave feedback to keep going "*Yes, good. Keep pressing!*"

Data recording and reduction: **Latency**. The repetitive counter pressing task provided data about the number of lever presses in 20 seconds. In order to have comparable scores with the other assessments, it was decided to calculate, for each child, the average time associated with a single click. The following formula was used to give response times in milliseconds: [(20 /

number of clicks) * 1000]. Trials on the right and left hand were combined and the mean response time was used as the summary statistic for subsequent analyses on this task.

2.3.4.2. Simple Motor

Material: The simple motor task was programmed using the SuperLab-Pro software for Windows and required children to press a key (marked by a blue coloured dot) as soon as a stimulus ("X") appeared on the screen. The location of the stimulus was randomised as follows: top right, top left, bottom right, bottom left and centre. The inter-stimulus interval took one of four pseudo-randomised values (i.e. from 1 to 4 seconds). This task comprised 4 practice trials and 20 test items.

Procedure: Children sat in front of the screen (30 to 60 cm away) and were instructed as follows: "*Now, look at the screen. You will see a "X" appear. As soon as you see this on the screen, you have to press this key* (demonstrate). *Remember, you have to press as quickly as you can but only when you see it on the screen. So you need to look at the screen all the time. Do you understand what you have to do? Are you ready?*" The start and end of a session were signaled both by a visual display and by verbal instruction. Before the start of the test items, 4 practice trials were given so as to ensure children were familiar with the task. Children had 10 trials using each hand.

Data recording and reduction: Outliers were identified (2SD above or below the average mean of the age group) and replaced by the mean for the age group under consideration. Trials on the right and left hand were combined and the mean response time was used as a measure of children's simple reaction time.

2.3.4.3. Choice Motor

Material: The task was programmed using the SuperLab-Pro software for Windows. Children were instructed to press one of two keys (C and M, both marked by a yellow coloured dot) to indicate the presence of one of two types of stimuli ("X" and "O"). The keys were not far apart and on the same row on the keyboard, for ease of response. Children thus had to use both hands. The stimuli appeared an equal number of times (10 times each) across 5 screen locations as follows: top right, top left, bottom right, bottom left, and centre. The inter-stimulus interval took one of four pseudo-randomised values (i.e. from 1 to 4 seconds). This task consisted of 4 practice trials and 20 test items.

Procedure: Children sat away from the screen (30 to 60 centimetres) and were instructed as follows: "*Now look at the screen. You will see one of two things appear. You will see either a "X" or a "O" appear on the screen (draw shapes on paper so there is no ambiguity). Use both your hands like this (demonstrate how index finger of both hands hovers lightly over the yellow coloured keys) and keep looking at the screen all the time. Now listen carefully: if "X" appears, you press this key ("C") but if a "O" appears, you press that key ("M"). Try to be as quick as you can. Do you understand what you have to do? Are you ready?*" The start and end of a session were signaled both by a visual display and by verbal instruction. Children had 4 practice trials prior to the start of the test per se.

Data recording and reduction: Both the speed and the accuracy of responses were recorded by the child pressing a colour coded key. Latency analysis was based on correct responses and outliers were replaced by the mean for the age group under consideration. Fifty-four percent of the correlations were significant, with 68% of the correlations $\geq .30$. The mean latency of the 20 trials was calculated for each child and this summary statistic was then used for subsequent data analysis. Accuracy responses, as before, consisted in the total number of correct items on the whole set.

III. Overview and Summary

The current chapter described the various measures used to assess both lexical and non-lexical abilities involved in the naming process of a sample of 105 typical children. Two types of naming tasks were employed (discrete and serial); measures of phonology, semantics and speed of response to non-lexical tasks were also used so as to provide a comprehensive profile of children's performance on naming and the component processes of naming. Chapter III will take this issue forward and examine the speed of response on naming and other related (lexical and non-lexical) abilities discussed in the current chapter. Following this, Chapter IV will tackle issues concerning the accuracy of naming and its related lexical (i.e. semantic and phonological) abilities.

CHAPTER III

THE SPEED OF DISCRETE AND SERIAL NAMING

I. INTRODUCTION

As already discussed in Chapter I, speed and accuracy of naming can provide important insights into the process of lexical retrieval. Accuracy provides an indication of the integrity (and/or accessibility) of the lexical representations (see Chapter IV); whereas the speed of naming gives an indication of how efficiently individuals are able to access this information and this is the focus of the current chapter. The chapter is organised around four themes. The first concerns whether participant characteristics influence speed on response on a range of tasks which have been described in Chapter II. The second theme concerns the relationship between speeds of serial and discrete naming to better understand whether these two tasks involve similar cognitive processes. The third theme concerns the relationship between speed of naming and speed of response on non-lexical tasks to address questions about whether naming speed is the product of general information processing abilities. The fourth theme concerns identification of cognitive processes that predict serial and discrete naming speeds.

1.1. Participant Variables in Relation to Naming and Other Cognitive Abilities

It was decided to investigate two participant characteristics in relation to naming processes, age and gender. A number of studies, mainly originating from Kail and his colleagues (Kail, 1988; 1991; 1994; 2000), have documented that with increasing age response times to a range of stimuli decrease. For instance, Kail (1991; see also Kail, 1994; 2000) investigated the timed response of 8 to 21 year olds by compiling findings from 72 studies and reported the presence of consistent patterns of age differences across a range of tasks (e.g. naming, mental rotation, memory search, simple reaction time and so on). Similar findings focusing on perceptual-motor processes are available from Miller & Vernon (1997) examining 4 to 6 year olds.

Although less information is available, there is evidence that age-related changes also operate in relation to lexical processing involving semantic, phonological abilities and related language abilities. For example, Kail et al. (1999) found that 7 to 13 year old children tended to be faster, with increasing age, on measures on naming and reading comprehension (see also Windsor & Kohnert, 2004 with 8 to 13 year olds). Recently, Kail & Miller (2006) used a greater range of tasks including measures of judgment of rhyme (phonology) and judgment of grammaticality to examine changes in the speed of processing of 9 and 14 year olds. Findings showed that speed of response was lower in the older children. Kail & Miller argued that there is a "*global mechanism – [...] one that is systemic and not specific to a particular task – [that] might underlie developmental change in processing speed*". (p. 119).

When considering age related changes in a set of variables it can be useful to analyse whether all the variables show the same trajectory. Troia & Roth (1996) investigated 22 typical kindergarten and 8-9 year olds on measures of discrete and serial naming. Findings indicated that the older children were significantly faster than the younger children (see also Kail et al., 1999 for serial naming at 7-13 years or Meyer, Wood, Hart & Felton, 1998 for serial naming at grades 1 to 8). In relation to serial naming speed, some researchers have found a plateau at ages 8/9 (Denckla & Rudel, 1976a; Semel & Wiig, 1980). However, other more comprehensive studies suggest response times continue to decline until adolescence (e.g. see Meyer et al., 1998). Because direct comparisons between these two measures are scarce, it was decided to investigate their trajectory during the primary school years.

Gender is another possible contributor to differences in response speed. It is generally believed that girls outperform boys on a range of assessments (Duckworth & Seligman, 2006; Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991) and that the language system of girls is more advanced than boys (Doran, 1907; Huttenlocher et al 1991; Maccoby & Jacklin, 1974; Bornstein, Hahn & Haynee, 2004) and matures at a more rapid pace than boys (McClure, 2000). However, investigations do not appear to have been conducted in relation to response times on lexical and non-lexical tasks and consequently it was decided to determine whether there are gender differences on these tasks.

1.2. Serial and Discrete Naming Tasks - Different or Shared Processes?

The differences between serial and discrete naming reside in the assessment procedure and the type of stimuli used. Discrete (or confrontational) naming involves naming pictures, one at a time; whereas serial (or continuous naming) involves naming a limited set of highly familiar items presented in sequence on one page. Studies of children with dyslexia have typically used the serial naming format (Manis et al., 2000; Wolf & Bowers, 1999) whereas the discrete naming procedure has mostly been used in studies of children with language difficulties (Dockrell et al., 2003).

Although both tasks have been used extensively, they have rarely been used together (but see Bowers & Wolf, 1993; Berninger et al., 1997). As a result, it is not clear whether serial and discrete naming involve similar (or distinct) cognitive processes. Consequently, the relationship between these two types of measures in typical children can shed light as to whether (and to what extent) both forms of naming involve the same cognitive processes. If similar cognitive processes are involved, one would expect performance on the two tasks to be strongly correlated. One might also expect that the two variables would have similar relationships with other variables (e.g. assessments of phonological and semantic abilities). Thus, similar patterns of predictions would be expected from multiple regression analyses, and these would also help identify the critical predictors of these two forms of naming (see section 1.4. and Chapter IV).

1.3. Is Naming Speed Related to Speed of Response on Non-Lexical Tasks?

Some investigations of children with disabilities suggest that slower naming speed might be a product of an impaired language system (see Chapter 1). For example, both Snowling et al. (1998) and Swan & Goswami (1997) argue that imprecise phonological representations cause the slower naming speed children with dyslexia and also explains why these children make more phonological errors. It also has been proposed by Nation and colleagues that poor comprehenders are slow at naming because of their difficulties with processing semantic information (Nation et al., 2000; 2004; 2005; Nation & Snowling, 2000). In addition, Wolf & Bowers (1999) claim that the speed of serial naming involves a form of information processing that is related to reading comprehension abilities. However, other researchers have suggested that children with language difficulties also show slower responses when processing non-language based stimuli (Hill, 2001; Bishop, 2002; Kail & Hall, 1999; Windsor & Hwang, 1999).

It was therefore decided to investigate whether the speed of serial and discrete naming was related to the speed of responding to simple non-lexical stimuli. If naming speed is governed by linguistic processes one would expect it to be unrelated to the speed of response to non-lexical stimuli. However, if there is a common mechanism underlying speed of processing on lexical and non-lexical tasks, then one would expect speeds of response on such tasks to be correlated.

To investigate this question it was decided to first calculate correlations between the speed of response to non-lexical stimuli and naming speed without co-varying for age. In this way, it was possible to look at the strength of each of the bivariate relations, and to assess the importance of non-lexical tasks for predicting the speed of naming. These analyses were followed by multiple regression analyses where age was always entered in the first block by itself, with the assessment of non-lexical response times being entered separately in a subsequent block. In this way it was possible to asses whether the speed of response on non-lexical tasks significantly contributed to the prediction of naming speed (the multiple regression analyses also contained a block of variables that assessed the speed of response on language based tasks see below).

1.4. Predictors of Discrete and Serial Naming Speeds

There is a lack of data about the relation between serial and discrete naming (see section 1.2). In addition, there have been suggestions that these two forms of naming might involve different cognitive processes. In relation to serial naming, Vukovic & Siegel (2006; p. 26) state there is a "*lack of an agreed-upon operational definition*" concerning what the RAN measures. Some of the earlier work on serial naming, and particularly the RAN, considered the task to be *part of the phonological family*

(Torgesen, Wagner, Rashotte, Burgess & Hecht, 1997; Torgesen, Wagner, Rashotte, Rose, Conway, Lindamood & Garvan, 1999; Snowling & Hulme, 1994). A reason for this was the fact that children with dyslexia, who have poor phonological abilities, tended to be slower than typical children on RAN assessments. If this claim is accurate then one would expect performance on the RAN to be related to phonological processing abilities.

However, Wolf & Bowers (1999) have recently rejected the idea that serial naming involves a phonological ability. Instead, they claimed that serial naming assesses an important aspect of information processing which is relevant to reading comprehension. Furthermore, a number of investigators believe that the RAN reflects *automatic access to characters* in linking visual symbols with lexical codes in memory (Bowers & Wolf, 1993; 1999; Kail & Hall, 1994). Georgiou, Parrila & Kirby (2003; 2006) recently illustrated the complex nature of the RAN by specifying how factors such as the pause time between naming items is an important determinant of the total RAN time (see also Cobbold, Passenger & Terrell, 2003; Neuhaus & Swank, 2002). This type of explanation suggests that the RAN is not related to phonological abilities, but involves rapid efficient responding and processing of information (Denckla & Cutting, 1999; Wolf & Bowers, 1999) and as such, is a *marker for processes sensitive to precise and rapid timing* (Bowers, Sunseth & Golden, 1999; p.32). Discrete naming, on the other hand, is believed to reflect a complex form of word-retrieval (see Chapter 1), with emphasis on the extraction of *higher-level* semantic processes (Wolf & Obregon, 1992), where naming is highly dependent on vocabulary knowledge. Consequently, discrete naming may be more strongly related to semantic processes than to phonological processes.

To investigate these possibilities correlations first will be calculated of the relationships between the speed of response on tasks designed to assess components of lexical production and the speed of discrete and serial naming. Subsequently, multiple regressions will be used to assess the relative contribution of (i) age, (ii) speed of response on tasks involving lexical abilities and (iii) speed of response on tasks involving non-lexical stimuli to the prediction of naming speed.

1.5. Research Questions

The present study investigates how the speed of response on semantic, phonological and non-lexical tasks relates to the speed of naming in a sample of typical children. Several considerations have provided the impetus to the present study; the need to look at developmental aspects of the naming process; the lack of systematic investigations of a range of factors in relation to typical naming processes; a lack of a coherent and comprehensive picture of the way that different cognitive abilities are related to naming and how they influence the ability to name quickly. The following issues will be addressed in this chapter:

1. The influence of age and gender on children's speed of response on lexical and non-lexical tasks.
2. The relationship between discrete and serial naming speeds.
3. The relationship between naming speed and speed of response on non-lexical stimuli.
4. The identification of predictors of discrete and serial naming speed.

II. METHODOLOGY

Participants' characteristics, tasks and procedure have been described in the previous chapter. Parametric statistics were used to minimise the number of different analyses and to enable the use of more sophisticated analyses. Differences in performance according to age or gender were examined by use of analyses of variances and post-hoc comparison tests (Tukey and Bonferroni where appropriate) to specify the significant results. The relation between variables was examined using Pearson's correlation coefficient (Bonferroni adjustments are provided). Age was not used as a covariate when carrying out these correlations in order to maximise the variance in the scores. However, this issue of age effects was addressed in hierarchical multiple regression analyses where the effect of age was controlled when examining the predictors of naming speed.

Analysis of response times: Data analysis was based on correct responses only (see Chapter II; p.52 for justification). As described in chapter II, outliers were identified as responses that were 2 standard deviations above or below the mean. For each child, outliers were replaced by the mean response time for the item in question from the corresponding year group.

III. RESULTS

3.1. Participant Characteristics in Relation to Speed of Response

This section considers differences in speeds of response first in relation to age, and then in relation to gender.

Table 1: Mean latency of response in milliseconds (standard deviations in brackets) at each age and for the whole sample

Tasks	Year 2 [6/7]	Year 4 [8/9]	Year 6 [10/11]	Average mean	% decrease	Sig. (2-tailed)
Counter pressing	361 (46)	291 (37)	273 (25)	308 (53)	24	$F(2, 102) = 54.898$; $p < .001$ Yr 2 < (Yr 4 = Yr 6)
Simple motor	524 (82)	377 (36)	361 (46)	421 (94)	31	$F(2, 102) = 82.368$; $p < .001$ Yr 2 < (Yr 4 = Yr 6)
Lexical Decision	820 (231)	723 (193)	582 (147)	708 (215)	29	$F(2, 102) = 13.329$; $p < .001$ (Yr 2 = Yr 4) < Yr 6
Choice motor	910 (148)	658 (77)	605 (91)	724 (172)	34	$F(2, 102) = 77.513$; $p < .001$ Yr 2 < (Yr 4 = Yr 6)
RAN	986 (157)	781 (110)	617 (83)	795 (194)	37	$F(2, 102) = 82.137$; $p < .001$ Yr 2 < Yr 4 < Yr 6
Categorisation	1403 (132)	1150 (93)	1105 (83)	1219 (168)	21	$F(2, 102) = 81.980$; $p < .001$ Yr 2 < (Yr 4 = Yr 6)

Picture Naming	1856 (259)	1744 (154)	1648 (194)	1749 (222)	11	F (2, 102) = 8.947; p < .001 Yr 2 < Yr 6
Definition	3520 (1046)	2613 (692)	2538 (675)	2890 (930)	28	F (2, 102) = 15.456; p < .001 Yr 2 < (Yr 4 = Yr 6)
Odd-one-out**	3656 (877)	3538 (1041)	3447 (867)	3547 (927)	6	F (2, 102) =.444; p = .643

% decrease between Year 2 and Year 6 calculated as follows: [((Year 2 – Year 6) / Year2) x 100]

Table 1 and Figure 1 show a consistent decrease in children's timed responses, across the 3 ages. The biggest decreases in latency of response occurred on the serial naming task and on the three non-lexical tasks and on two of the three non-lexical tasks, namely the choice and simple motor tasks. There also were large differences in the latencies, with the latency of response on the semantic offline tasks being longer than speed of response on the online tasks. Also of note, the fastest response times were obtained on the non-lexical tasks.

A 3-way ANOVA was used with age and gender as the two between-subjects factors and type of task as the within-subjects factor. Bonferroni adjustments were used to compare main effects and interaction effects. Table 2 summarises these findings.

Table 2a: Results of 3-way ANOVA: Type of task x Age (3) x Gender (2) for between-subjects factors

Between-subjects effects	Significance	Partial Eta ηp^2
Main effects		
Age	$F(2, 99) = 33.194; p < .001$	.401
Gender	$F(1, 99) = .182; p = .671$	---
2-way interaction		
Age x Gender	$F(2, 99) = .417; p = .660$	---

Effect size: $\eta p^2 < 0.01$ (small effect); $0.01 < \eta p^2 < 0.10$ (medium effect); $\eta p^2 > 0.10$ (large effect)

A main effect of age was obtained, thereby confirming that response times decreased significantly with development. Post-hoc multiple comparison analyses showed that overall Year 2 children were significantly slower than the Year 4 and Year 6 children (at $p < .001$) and no significant difference between Year 4 and Year 6 children. However, post hoc tests showed different patterns of age-related changes for specific tasks (these are summarised in Table 1). There was no main effect of gender (see Appendix F for summary statistics in relation to gender) or interaction between age and gender.

Table 2b: Results of 3-way ANOVA: Type of task x Age (3) x Gender (2) for within-subjects factors

Within-subjects effects	Significance	Partial Eta ηp^2
Main effects		
Type of tasks	$F(8, 792) = 707.351; p < .001$	.877
2-way interaction		
Type of task x Age	$F(16, 792) = 4.160; p < .001$	.078
Type of task x Gender	$F(8, 792) = .925; p = .495$	---
3-way interaction		
Type of task x Age x Gender	$F(16, 792) = .478; p = .958$	---

Effect size: When $\eta p^2 > 0.10$ => large effect observed

In relation to the within-subjects factors, a main effect of task was observed (Table 2b). Post-hoc comparisons (with Bonferroni adjustments) showed:

(a) A significant difference between the RAN and the lexical decision task ($p = .023$);

(b) No significant difference between response times on the choice motor and lexical decision tasks;

(c) All other response times differed significantly from one another at the 1% probability level.

The ANOVA also revealed a significant interaction between type of task and age. This could be because the response times on some of the tasks did not change with age, or that differences between tasks occurred at some ages and not others. The percentage of decrease between Year 2 and Year 6 was calculated (see Table 1) to identify the tasks that showed the smallest age-related decline in response speed. The smallest decrease was observed on the semantic odd-one-out (6%). An ANOVA confirmed a lack of significant difference across the 3 ages on this task ($p = .643$). The next smallest decrease was observed on the picture naming task (11%). However, the ANOVA revealed a significant difference according to age (see Table 1 for post hoc). Because this effect was significant no further post-hoc tests in relation to age were conducted.

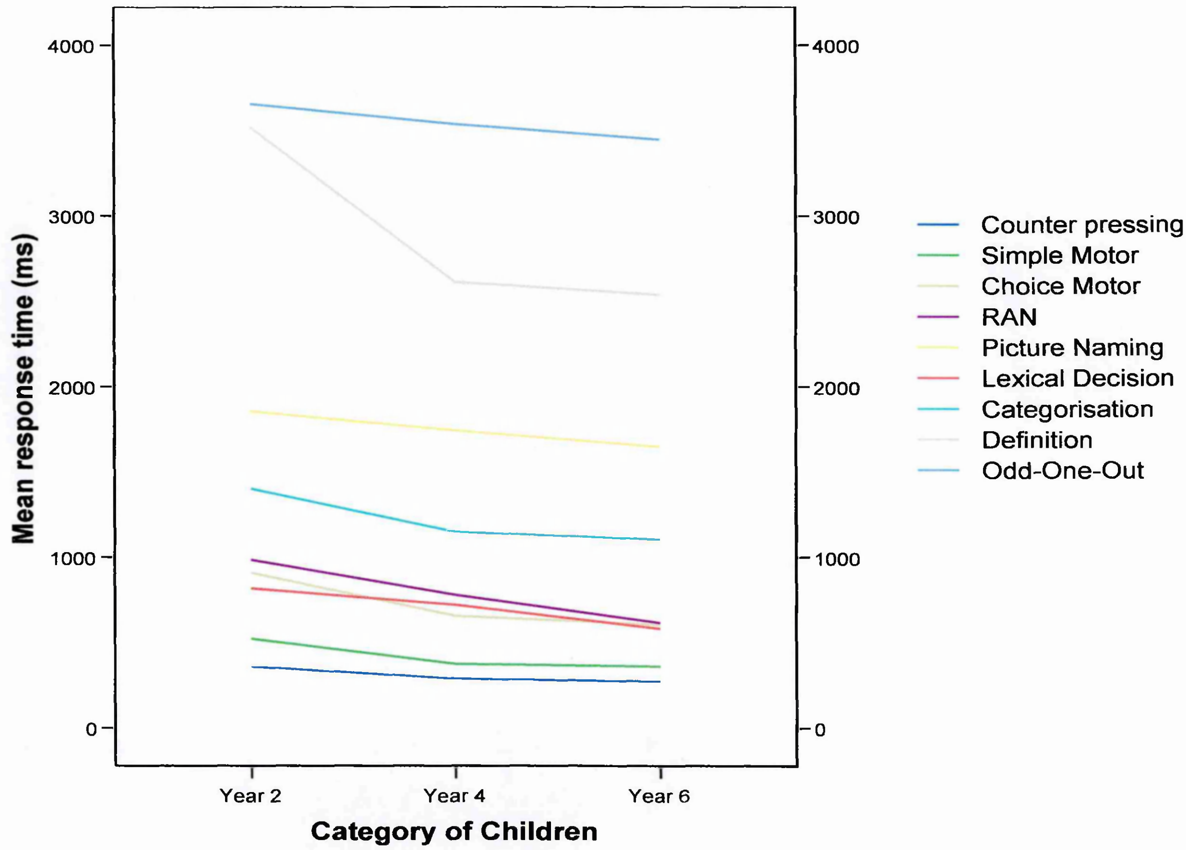
Figure 1 (below) was used to identify where differences in response times between tasks might be non-significant at a particular age. Post-hoc analyses began with the smallest differences. Paired t-test indicated that:

(a) At Year 2 response times on the odd-one-out (M = 3656; SD = 877) did not differ significantly from response times on the definition task (M = 3520; SD = 1046) – with t (34) = .603; p = .551. Similarly response times between the lexical decision (M = 960; SD = 407) and RAN (M = 987; SD = 158) – with t (34) = -.333; p = .741; lexical decision (M = 960; SD = 407) and choice motor (M = 967; SD = 252) – with t (34) = -.105; p = .917; and RAN (M = 987; SD = 158) and choice motor (M = 967; SD = 252) – with t (34) = .404; p = .689, were not significantly different;

(b) At Year 4 there was no significant difference between mean response times on the lexical decision (M = 911; SD = 392) and the RAN (M = 781; SD = 110) – with t (34) = 1.861; p = .071;

(c) Finally at Year 6, response times were not significant between the RAN (M = 615; SD = 82) and choice motor (M = 612; SD = 115) – with t (34) = -.164; p = .871 and between the lexical decision (M = 718; SD = 308) and the RAN (M = 615; SD = 82) – with t (34) = 1.950; p = .059.

Figure 1: Distribution of children's timed performances across the three ages



3.2. Relationship between Discrete and Serial Naming Speed

As illustrated by Table 3, correlations between all the measures of serial and discrete naming were significant (at $p < .001$). There were a moderate set of correlations between the serial and discrete naming speeds, thereby suggesting that some common processes are shared but that the two tasks do not involve exactly the same ability. All correlations remained significant after Bonferroni adjustments (where the ssignificance level was identified as $p < 0.003$).

Table 3: Pearson correlation between mean speeds of response on discrete and serial naming tasks for the whole sample (N = 105)

	Picture Naming	RAN Letter	RAN Colour	RAN Object	RAN Number	RAN Combined
Picture Naming						
Pearson correlations (N = 105)	---	.299**	.403**	.388**	.407**	.427**
Sig. (2-tailed)		.002	.001	.001	.001	.001
RAN [Letter]						
Pearson correlations (N = 105)		---	.726**	.745**	.771**	.901**
Sig. (2-tailed)			.001	.001	.001	.001
RAN [Colour]						
Pearson correlations (N = 105)			---	.698**	.699**	.891**
Sig. (2-tailed)				.001	.001	.001
RAN [Object]						
Pearson correlations (N = 105)				---	.593**	.896**
Sig. (2-tailed)					.001	.001
RAN [Number]						
Pearson correlations (N = 105)					---	.828**
Sig. (2-tailed)						.001
RAN [Combined]						
Pearson correlations (N = 105)						---
Sig. (2-tailed)						

**Correlations significant at the .01 level (2-tailed)
*Correlations significant at the .05 level (2-tailed)

3.3. Relation between Naming Speed and Speed of Response on Non-Lexical Tasks

The degree of association between measures of non-lexical response times was strong (r on average .66) suggesting that these tasks shared a common element (see Table 4). In addition, positive correlations were obtained between the response times on the three non-lexical tasks and the two naming tasks (see Table 4). Correlations between the response speed on non-lexical tasks and discrete naming were moderate (with $r = .31$ on average), but high with serial naming (with $r = .68$ on average). Correlations remained significant after Bonferroni adjustments (with the significance level identified as $p = .005$).

Table 4: Pearson correlation (sig. value in brackets) between speeds of response on lexical and non-lexical tasks

		Tapping task	Simple Motor	Choice Motor
NON-LEXICAL TASKS	Tapping task	—	.650** (.001)	.615** (.001)
	Simple Motor		—	.715** (.001)
	Choice Motor			—
	Picture Naming	.324** (.001)	.314** (.001)	.279** (.004)
NAMING TASKS	RAN combined	.696** (.001)	.698** (.001)	.631** (.001)

Correlations significant at the .01 level (2-tailed)
***Correlations significant at the .05 level (2-tailed)**

3.4. Predictors of Naming Speeds: Relative Contribution of Semantic and Phonological Abilities

This section aims to assess the contribution of different cognitive processes to the prediction of discrete naming speed [DV1] and to the prediction of serial naming speed [DV2]. Analyses are presented in two stages: first, correlations between the independent variables and the two dependent variables were examined. Second, a hierarchical multiple regression analysis was then conducted to determine the best predictors of naming speed.

As illustrated in Table 5, overall, correlations were stronger with speed of serial naming than speed of discrete naming. The variable with the strongest correlation with both types of naming was age. In contrast, response times on the odd-one-out task were not significantly correlated with naming. In order to reduce the number of variables entered in the regression equation; it was decided to omit this task from subsequent analyses. Likewise, the definition task was not entered in the regression analyses (for prediction of discrete naming speed) for similar reasons. Most of the other variables had moderate and significant correlations with both forms of naming.

Table 5: Correlations between naming speeds and other speeds of response

Response time variables		**DEPENDENT VARIABLES**	
		Picture Naming	**RAN**
	Lexical Decision	.214**	.369**
LEXICAL	Categorisation	.372**	.645**
ABILITIES	Definition	.108	.415**
	Odd-One-Out	-.009	.039
	Counter pressing	.324**	.695**
NON-LEXICAL	Simple Motor	.314**	.698**
ABILITIES	Choice Motor	.279**	.631**
	Age	-.407**	-.799**

****Correlations significant at the .01 level (2-tailed)**
***Correlations significant at the .05 level (2-tailed)**

3.4.1. Predictors of Discrete Naming Speed

Variables entered in the regression were: age (in months), speeds of response on the lexical decision and categorisation tasks, and speeds of response on the three non-lexical tasks i.e. counter tapping, simple and choice motor tasks. Regarding the selection of the independent variables to be entered in the regression equation, researchers recommended using at least 15 participants per predictor variable (see Howitt & Cramer, 2005; Tabachnick & Fidell, 1996 – p.132). For the current sample size of 105 children, this limits the number of IVs to 7. The initial criterion restricting the number of independent variables (i.e. not to exceed 7) was therefore satisfied.

Variables were entered in separate blocks. In order to control for the effect of age, this variable was entered in a first block for all the analyses. Two models were tested: in one model lexical representations were entered in a second block and non-lexical representations in a third block. In a second model, this order was reversed (though age was still in the first block). Because the output was similar for both models, it was decided to present findings for model 1.

Age explained a significant percentage (16%) of the variance of discrete naming speed $F(1, 103) = 20.426$; $p < .001$. Measures of semantic and phonological ability did not contribute to a significant portion of the variance in discrete naming speed $F(2, 101) = .759$; $p = .471$. Likewise, speeds of response on the non-lexical tasks did not explain a significant percentage of the variance of discrete naming speed $F(3, 98) = .289$; $p = .834$. The findings are summarised in Table 6 below.

Table 6: Identification of the speed predictors of discrete naming speed

Blocks		β	Standard error β	Beta	Sig. (2-tailed)
Block 1					
	Age	-3.22	1.79	-.30	.076
Block 2: [Lexical tasks]					
	Categorisation	.24	.20	.18	.225
	Lexical Decision	.03	.11	.03	.785
Block 3 [Non-lexical tasks]					
	Counter task	.19	.57	.04	.731
	Simple motor	.05	.35	.02	.878
	Choice motor	-.17	.20	-.13	.379

***Significant at .05**
****Significant at .01**

3.4.2. Predictors of Serial Naming Speed

Following the rationale used for discrete naming, variables were entered into the multiple regression analysis in the same three blocks - with the testing of the same two models. Because the output was similar for both models, it was decided to present findings for model 1.

Age explained a significant percentage (64%) of the variance of serial naming speed $F(1, 103) = 184.224$; $p < .001$. Measures of lexical ability (i.e. semantics and phonology) did not add a significant increase to this variance $F(3, 100) = 1.200$; $p = .314$. However, speed of response on the motor tasks explained a significant portion (5%) of this variance $F(3, 97) = 3.672$; $p = .015$. The output is summarised in Table 7 below.

Table 7: Identification of the speed predictors of serial naming speed

Blocks		β	Standard error β	Beta	Sig. (2-tailed)
Block 1					
	Age	-4.48	.98	-.48	p < .001
Block 2:					
	Lexical decision	.02	.06	.02	.688
	Categorisation	.05	.11	.04	.649
	Definition	.01	.01	.05	.433
Block 3					
	Counter task	.66	.31	.18	.036*
	Simple motor	.40	.19	.19	.042*
	Choice motor	-.04	.10	-.04	.677

***Significant at .05**
****Significant at .01**

IV. DISCUSSION

The following sections address issues about: (i) gender and age in relation to speed of response on lexical and non-lexical tasks; (ii) the relation between discrete and serial naming speeds and (iii) the prediction of naming speed from other variables.

4.1. Role of Age and Gender on Speed of Response on Lexical and Non-Lexical Tasks

No significant differences were found between boys and girls, even though girls had faster response times on 7 out of 8 assessments (two of these differences neared significance levels, namely on the RAN and on the definition– see Appendix F). However, one ought to be cautions when interpreting these findings as there not being a difference in response speed between girls and boys. Indeed, it is worth bearing in mind that studies of gender differences across a range of language and non-language abilities often employ large samples, and that the power provided by such large populations may be necessary to detect gender differences where there is an overlap in the distribution of the abilities and small differences between the populations (Bornstein et al. 2004: used 329 children; Duckworth and Seligman with 140 children).

In contrast to the lack of effects of gender, a main effect of age was identified; Year 2 children were significantly slower than Year 4 and Year 6 children. Thus, across the range of tasks used in this study performance appeared to reach a plateau by Year 4. However, post-hoc analyses revealed a more complex picture of age related differences, with several different developmental patterns.

The post-hoc analyses showed that only in one case, involving serial naming (RAN), were there significant differences in speed of processing between each of the three ages. Some previous researches using the RAN have failed to detect age related changes (Denckla & Rudel, 1974; 1976b Semel & Wiig, 1980). Differences between the current findings and, for example, the work of Denckla might reside in differences in sample size (Denckla's 1974 study used 180 typical children from 6 different age groups spanning the 5 to 11 year age range) or type of sample used (Denckla's 1976 research looked children with dyslexia with minimal brain damage in relation to typical controls). In contrast, more recently, a comprehensive study of serial naming by Meyer et al. (1998) identified age related changes in a sample of 154 children with reading difficulties and a typical control group. Meyer and colleagues found that naming speed levelled off around Grade 8 (i.e. 13-14 years) and that the greater decreases were observed between Grades 1 (6-7 years old) and 3 (8-9 years old). The findings from the current study are in agreement with those of Meyer et al. (1998) and suggest that if a plateau is reached in performance on this task, then it is likely to be in adolescence.

In contrast to serial naming, significant differences in the speed of discrete naming were only present between Year 2 and Year 6. Part of the reason for this different pattern of findings could be the selection of the stimuli. In the serial naming task the same (highly familiar) stimuli were used by all children. The speed of discrete naming involved a different selection of stimuli. The response times were based on correct responses and as a consequence the stimuli may have changed – i.e. older children were likely to have a larger sample of correct words and these would include some words they had recently acquired. Because of this the discrete picture naming task may either have continued to be of similar difficulty across different ages or even have increased in difficulty with the age of the children. Thus, part of the reason for weaker age effects in discrete naming, compared to serial naming, could be the nature of the task employed. Even so it is worth emphasising that there was an age difference between Year 2 and Year 6, and despite the possibility of the task becoming more difficult with age, older children were succeeding in responding more quickly.

The three assessments involving non-lexical response times showed that Year 2 children were significantly slower than Year 4, but there was no significant difference between Year 4 and Year 6 children; although in every case the mean response time decreased with age. As these tasks contained the same stimuli at all three ages it would appear that children's speed of responding to very simple stimuli could plateau at Year 4 or that as children get older their improvements in speed become less marked. The later suggestion is consistent with findings by Kail that children become progressively faster at a range of language and non-language tasks until at least adolescence (Kail, 1991; 1994; Kail & Miller, 2006; Miller & Vernon, 1997).

The assessments of abilities related to lexical processing showed a range of significant differences between the three ages, although for all the tasks the mean reaction times decreased across the three ages. For one of the tasks, there was no age related difference (odd-one-out); for another task, Year 6 children were faster than the other two age groups (lexical decision), and for two tasks Year 2 children were slower than children at the other two ages (categorisation and definition). These findings suggest that the speed of processing lexical information becomes faster with increasing age, but that for different types of task, slightly different developmental profiles occur.

At this point it is worth commenting on the difference in the response speeds across the various tasks. Not surprisingly the two tasks with the simplest information processing demands had the shortest response time (counter pressing and simple motor). The next three quickest response times involved tasks that contained additional but not extensive information processing demands (choice motor, RAN and lexical decision), but all involved semi-automatic and/or online responses. Two tasks which involved processing semantic information about the stimulus (categorisation and picture naming) were considerably slower than the tasks already discussed, and this suggests that the processing of semantic information makes response times much slower. The two slowest tasks involved offline processing (definitions and odd-one-out), and this can be accounted for by the high metacognitive demands of these tasks (Kempler et al., 1998; Ralli, 1999; Shapiro et al., 1998).

The current results therefore confirmed that processing speed on a range of tasks was faster with development and maturation (Cerella & Hale, 1994; Clark & Johnson, 1988; Kail et al., 1999). Also, findings revealed that maturation affected the naming stages differentially. Age-related differences in pattern might reflect a more efficient allocation of resources (Kail & BIsanz, 1982b; Salthouse, 1996). Practice and experience with words might (Kail, 1988) also explain how the mental work involved in particular cognitive operations becomes less taxing and more automatic with age (Logan 1985; 1988; Kail, 1988).

4.2. Relationship between Discrete and Serial Naming Speeds

A second issue concerned the relationship between the two forms of lexical retrieval i.e. discrete and serial naming. As already mentioned, hypotheses from research on atypical populations of children suggest that discrete and serial naming might engage different processes (see Olson, 1994; Wagner, Torgesen & Rashotte, 1994), and thus, provide different sources of information about cognitive processes.

Bivariate correlations indicated a moderate degree of association between serial and discrete naming speeds (r on average .40). Previous studies have found similar or higher correlations. For example, Bowers & Swanson (1991) tested Grade 2 (6-7 year old) average and poor readers on various continuous (RAN) and discrete naming tasks (where the target was either presented in isolation, accompanied by relevant or accompanied by irrelevant items). These authors reported higher correlations (r = .65) but this might be due to the use of different populations. Berninger et al. (1997) assessed Grade 4 (9-10 year olds) and Grade 5 (10-11) average readers on a measure of discrete naming (Test of Word Finding) and a modified version of the RAN, and found correlations of r = .40.

These findings suggest that both forms of naming do not involve very closely related sets of abilities or sub-processes and might provide slightly different assessments of children's cognitive processes. As a result, studies showing that children with dyslexia have serial naming speed deficits whereas children with language impairments manifest discrete naming deficits do not necessarily imply that similar sets of abilities are *impaired* – because the abilities and processes involved in those two forms of naming may not be similar. See section 4.4. for further discussion of this topic.

4.3. The Prediction of Discrete and Serial Naming Speeds

The motivation for predicting discrete and serial naming speeds originated from two topics of research. One of these topics concerns whether children's speed of response on non-lexical tasks is related to their speed of response on naming tasks. Although this might seem unlikely based on some explanations about naming difficulties (Snowling et al., 1988; Nation et al., 2000), as already mentioned, there are indications that children with language disabilities tend to be slower on non-language based tasks than typical children (Bishop, 2002; Hill, 2001; Lahey & Edwards, 1996; Lahey, Edwards, & Munson, 2001). Furthermore, Kail's 'generalised slowing' hypothesis suggests that if children are slow at responding in one domain they are likely to be slow at responding in another domain (Kail et al., 1999; Miller et al., 2001).

The other of these topics is the research on adults and on children that suggests both semantic and phonological processes play an important role in both the accuracy and speed of naming (see Chapter 1). However, there are few studies involving children that have employed a range of assessments that tap into semantic and phonological processes that are likely to be involved in lexical production, and fewer still that have employed these assessments together with measures of non-lexical response speeds (but see Windsor & Hwang, 1999; Catt et al., 2002; Kail et al., 1999; Kail & Miller, 2006). Furthermore, most of these studies have taken as their focus the cognitive processes in atypical rather than typical children.

In the case of discrete naming speed, there were significant correlations with response times on both lexical and non-lexical tasks. However, these correlations were low to moderate, with the highest being .372 – and this was obtained on the measure of categorisation. There is therefore a suggestion that children's ability to access category membership (i.e. knowing which items belong to which category), influences speed of discrete naming. However, the analysis of predictors of discrete naming speed indicated that age was the variable that accounted for a significant proportion of the variance on discrete naming speed. Therefore, although discrete naming is related to speed of categorisation or speed of response on simple motor tasks, no one of these abilities is critical in determining the speed of discrete naming. This interpretation is supported by the findings from the multiple regression analyses, where only age was a significant predictor. A further implication of these findings is that speed of response on the discrete naming speed is more dependent on general ability (namely age) than on other types of lexical abilities.

Models of word production developed by Levelt and others (see Chapter I) suggest that there are a number of stages in the naming process, each of which with a particular time course (see Figure 2 of Chapter I). Even the simpler models of children's naming identify broader semantic and phonological stages (Johnson et al., 1996; Johnson et al., 1989). Consequently, the findings from the current research suggest that each component of lexical processing contributes a small part to the overall speed of discrete naming. However, in relation to this argument one should acknowledge that there could have been measurement error obscuring these relations, or that the range of tasks selected might have failed to identify a critical process.

In the case of serial naming speed, this had correlations of between .63 and .70 with the response speed on non-lexical tasks, and moderate correlations (.36 to .64) with tasks assessing lexical abilities (see Tables 3 and 5). All the correlations were higher with serial naming than with discrete naming. These findings suggest that the speed with which a child can respond to non-lexical stimuli is an important component of serial naming speed. This is in line with previous researchers' assumption that the RAN taps into *rapid efficient responding* (Denckla & Cutting, 1999). In addition, the findings suggest that speed of processing phonological and semantic tasks could be important predictors of serial naming speed. The categorisation tasks has the highest correlation with serial naming speed and this might be because serial naming appears to depend on the identification of each new stimulus, while the task of searching for phonological forms should be reduced by the limited set of stimuli.

The multiple regression analysis identified age as a significant an important predictor of serial naming speed with age accounting for 64% of the variance in this measure. None of the assessments of semantic or phonological processes made any further significant contribution to the prediction of serial naming speed. However, speed of response to non-lexical stimuli did make a significant additional contribution, with the counter and simple motor tasks being important contributors. Together the correlations and multiple regression analyses suggest that the speed with which children respond to simple stimuli is an important component of serial naming speed.

This finding of different sets of predictors for discrete and serial naming reinforces the earlier conclusion that these two tasks assess slightly different cognitive processes. This also corroborates Wolf & Bowers' (1999) claims that serial naming involves different cognitive processes to those present in discrete naming. The current findings help to explain the nature of the difference between the two tasks. It would appear that serial naming is correlated with both higher level cognitive processes involving semantics and phonology, but also is heavily dependant on children's general ability to respond quickly to any stimuli.

V. CONCLUSION

The results showed the presence of a main effect of age on both lexical and non-lexical sets of abilities however, gender failed to make a significant contribution. A second finding was that the speed of serial and discrete naming were only moderately correlated, suggesting that the tasks assessed slightly different sets of abilities. Regression analyses further specified the different processes involved in the two forms of naming. Specifically, the RAN appeared to be dependent on mechanisms involving a general speed of response. On the other hand, discrete naming appeared to be reliant on higher-level metalinguistic semantic ability. The results also showed that age and response speed on non-lexical tasks made independent and separate contributions to serial naming speed.

CHAPTER IV

ACCURACY OF NAMING

I. INTRODUCTION

The current chapter builds on the findings presented in the previous chapter by investigating children's naming accuracy and also their accuracy on tasks assessing semantic and phonological ability. Whereas response times give an indication about how quickly children access information, accuracy measures provide insight into the information contained in the lexicon. That is, information about the content of the lexical system and the integrity (or accessibility) of this information (Johnson & Clark, 1988; Johnson et al., 1996).

The chapter is organised around three issues. A first issue concerns the role of participant variables (age and gender) in relation to the accuracy of naming, but also in relation to accuracy on a range of related lexical abilities. A second issue concerns the relationship between speed and accuracy on both lexical and non-lexical assessments. A third issue identifies the predictors of naming in relation to tasks that assess the speed and accuracy of abilities believed to be involved in lexical processes.

1.1. Participant Variables in Relation to Naming and Other Cognitive Abilities

With regards to age, some studies have suggested a gradual increase in accuracy of naming and related processes while others suggest there is a plateau. For example, one of the earlier studies by Butterfield & Butterfield (1977) investigated the naming ability of typical participants at ages 4, 6, 8, 10, 20 and 70 and found that children gradually reached conventional (or adult) levels of accuracy. Similar findings were reported by Wiegel-Crump

& Dennis (1986; assessing typical children at ages 6, 8, 10, 12 and 14) and Fried-Oken (1982; with 4 to 9 year old typical children) who assessed children on confrontational naming. However, a second strand of research has indicated a different pattern in relation to naming accuracy. For example, Leonard et al. (1983) found no significant gains in accuracy of naming between 6 and 8 years. Likewise, Vance, Stackhouse & Wells (2005) examined 3 to 7 year old typical children on a confrontational naming task. In this study, significant gains in accuracy scores were observed up to the age of 5, but no longer afterwards. Vance and colleagues concluded that the lack of significant improvement between ages 6 and 7 exemplified the fact that children have acquired a mature phonological system (see also Grunwell, 1987). Therefore, the first issue addressed in this chapter is whether a plateau can be observed when investigating 6 to 11 year old children's naming accuracy. It was also decided to extend the scope of previous work by examining the pattern of age-changes across other dimensions of lexical ability (i.e. semantics and phonology). As Johnson (1992) stated, it is unclear whether maturation "*affects all stages of naming similarly or specific stages differentially*". It will thus be possible to contrast naming performance with those abilities that are an integral part of the naming process.

Another issue about participant characteristics concerns the importance of gender in relation to language and related abilities. It is generally believed that the language system of girls is more advanced than boys (Duckworth & Seligman, 2006; McClure, 2000). However, it is unclear when this superiority occurs and ceases. Some studies have reported consistent gender effects under age 2 but no longer afterwards (Huttenlocher et al. 1991; Maccoby & Jacklin, 1974; Reznick & Goldfield, 1989); other sets of findings have found that gender differences were no longer observed after 5 years of age (Bornstein et al. 2004). Yet other recent evidence has indicated that girls performed better than boys in terms of academic achievement throughout elementary, middle and high school (Duckworth & Seligman, 2006; Landgren, Kjellman & Gillberg, 2003). The message from these studies is contradictory. In order to examine this question, performance on a range of measures of naming, semantic and phonological abilities will be examined to determine whether gender differences occur in this sample.

1.2. Relation between Processing Speed and Accuracy on a Range of Lexical Abilities

The tasks used in the current research provide a range of assessments of a number of processes that are likely to be involved in lexical production (Levelt et al., 1999). For example, the semantic categorisation task gives information about children's knowledge of category membership. In contrast, the definition task provides an indication of children's knowledge about word meanings. In addition, the fluency task gives information about the connections between items in the lexicon (i.e. *semantic relatedness*) whereas the odd-one-out reflects children's ability to distinguish between related items. Likewise, it was decided to assess the accuracy of children's phonological knowledge of words (Snowling, 2000; Swan & Goswami, 1997a). A phonological awareness task was thus included to tap into children's ability to identify constituent sounds of words (through an *alliteration* and *rhyme* test). An auditory lexical decision task was also used as a means of providing a direct assessment of receptive phonological knowledge (or input phonological representations; see Martin & Saffran, 2002). In addition, the BPVS was used to provide an overall indication of the size of the lexical system. As can be seen, these tasks provide information at several levels (or stages) of processing in relation to models of naming.

Previous work has shown that semantic abilities are related to one another and to naming accuracy (McGregor et al. 2002a & b). Likewise the existing literature contains reports of associations between measures of phonology and vocabulary (Gathercole & Baddeley, 1993; Gathercole, Baddeley & Papagno, 1998; Michas & Henry, 1994) or phonology and serial naming (Torgesen et al. 1997). What has been less-documented is the inter-relationship between different components of the lexical system (i.e. measures of comprehension ability, naming, phonological and semantic ability) on speed and accuracy measures, and how strongly these measures are correlated. Thus, another of the aims was to investigate whether accuracy on tasks assessing the lexical system were inter-related and were related to discrete naming accuracy. One of two alternatives was envisaged. Either the various components of the lexical system would be related to one another, in which case better lexical abilities would be related to better naming accuracy. On the other hand, correlational analysis might indicate stronger relationships between some of these processes and naming accuracy, thereby suggesting that one or more cognitive processes are key determinants of naming accuracy.

Another related issue concerned the relationship between accuracy and speed on tasks involving lexical abilities. One might not necessarily expect these two types of variables to be related as they tap into different processes. Furthermore, some of the previous research has suggested that when faced with a contradictory instruction (speed instruction vs. accuracy instruction) young children will sacrifice either speed or accuracy (Garrett, 1922; Hick, 1952; Woodworth, 1899). For example, Brewer & Smith (1989) examined typical children on a range of serial-choice reaction tasks. They found that from 5.5 years to about 7, slower responding was consistently associated with increasing accuracy and, on the reverse, faster responding by decreasing accuracy. However, by age 9 the speed-accuracy trade-off was no longer observed. Another possibility is that children with more advanced lexical representations are both faster and more accurate on tasks assessing lexical abilities (Salthouse, 1996). Using a similar range of tasks (and similar ages to Brewer's sample), it was decided to examine the relation between speed and accuracy on measures of lexical ability.

These analyses will be extended to investigate the relationship between response times on tasks that do not involve any processing of language (simple, choice reaction time and speed of repetitive tapping) and accuracy of naming and other tasks which assess lexical processes (i.e. semantics and phonology). In relation to typical development, there is little systematic research about the relation between response times on non-lexical tasks and performances on a range of language measures (but see Lahey et al. 2001 for work on SLI). Even though the nature of the relationship remains unclear, i.e. causal or correlational (Miller et al. 2001; Rice, Wexler & Cleave, 1995), it is believed that a better understanding of this relationship could provide insight into information processing dynamics (Wickelgren, 1977) and the role of speed of processing in relation to naming difficulties. If correlations are observed between general processing speed and accuracy (accuracy of naming and of other related abilities), this would suggest that the cognitive system involving naming is influenced by children's general information processing abilities.

1.3. Predictors of Speed and Accuracy of Naming

The third issue addressed in this study concerns the identification of the predictors of naming accuracy using correlations and multiple regression analyses. The originality of the current research is that a comprehensive range of cognitive abilities that are believed to tap many significant aspects of the naming operation, have been assessed. In addition, data about speed and accuracy have been collected to gain insight into the relationship between content of the lexicon and how fast children access this information.

Most of the available analyses in previous studies involves correlational analysis, which only assesses the extent to which one or two variables are related to the naming process (see McGregor et al. 2002 – in relation to semantics and naming accuracy; and Gathercole, 1993; Dockrell, George & Lindsay, 1997; Constable et al., 1997; Snowling et al., 1988 – in relation to phonological awareness and naming). So much so that currently, little is known about the types of cognitive abilities that enable children to name quickly and accurately. The current analyses were thus conducted to extend the knowledge-base about typical naming processes and provide a better understanding of the way that different cognitive abilities are related to lexical access. Specifically, three sets of analyses will be conducted using multiple regressions. The first analysis will look at the role of accuracy variables in predicting the accuracy of discrete naming. The second analysis will investigate the role of speed variables in predicting the accuracy of discrete naming. To extend the analyses in Chapter III, a third analysis will examine the role of accuracy variables in relation to the speed of discrete and serial naming. This will therefore provide a more complete picture of the relationship between speed and accuracy variables and speed and accuracy of naming.

1.4. Research Questions

The main issues addressed in the chapter can be summarised as follows:

1. The relation of age and of gender with children's accuracy of response on lexical tasks.

2. The relationship between accuracy and speed on tasks assessing lexical and non-lexical abilities.

3. The identification of predictors of discrete and serial naming.

II. METHODS

The participants' characteristics, assessments and procedure have been described already in Chapter II. Following on from the design of the previous chapter, differences in performance according to age or gender will be examined by use of analyses of variance (where possible the effect size will also be presented) and post-hoc comparison tests to specify the significant results (Tukey and Bonferroni where appropriate). The relationship between variables will be investigated through Pearson's correlation coefficient (Bonferroni adjustments will be used). Finally, the predictors of naming accuracy will be assessed by use of hierarchical multiple regression analyses.

III. RESULTS

3.1. Participant Characteristics in Relation to Accuracy of Response

There was a consistent age-related increase in the number of items correct on most of the measures of lexical ability (see Table 1). The lowest levels of accuracy were obtained on the measures of phonological awareness and discrete naming. As indicated by Figure 1, there was a relatively smooth increase across ages for some tasks (lexical decision, odd-one-out); whereas a steeper increase was observed between Year 2 and Year 4 on other assessments (phonological awareness, definition, picture naming). The greatest 'leap' in terms of correct responses was observed in relation to the discrete picture naming task.

Table 1: Accuracy and raw scores (standard deviations in brackets) on measures of lexical ability for the whole sample.

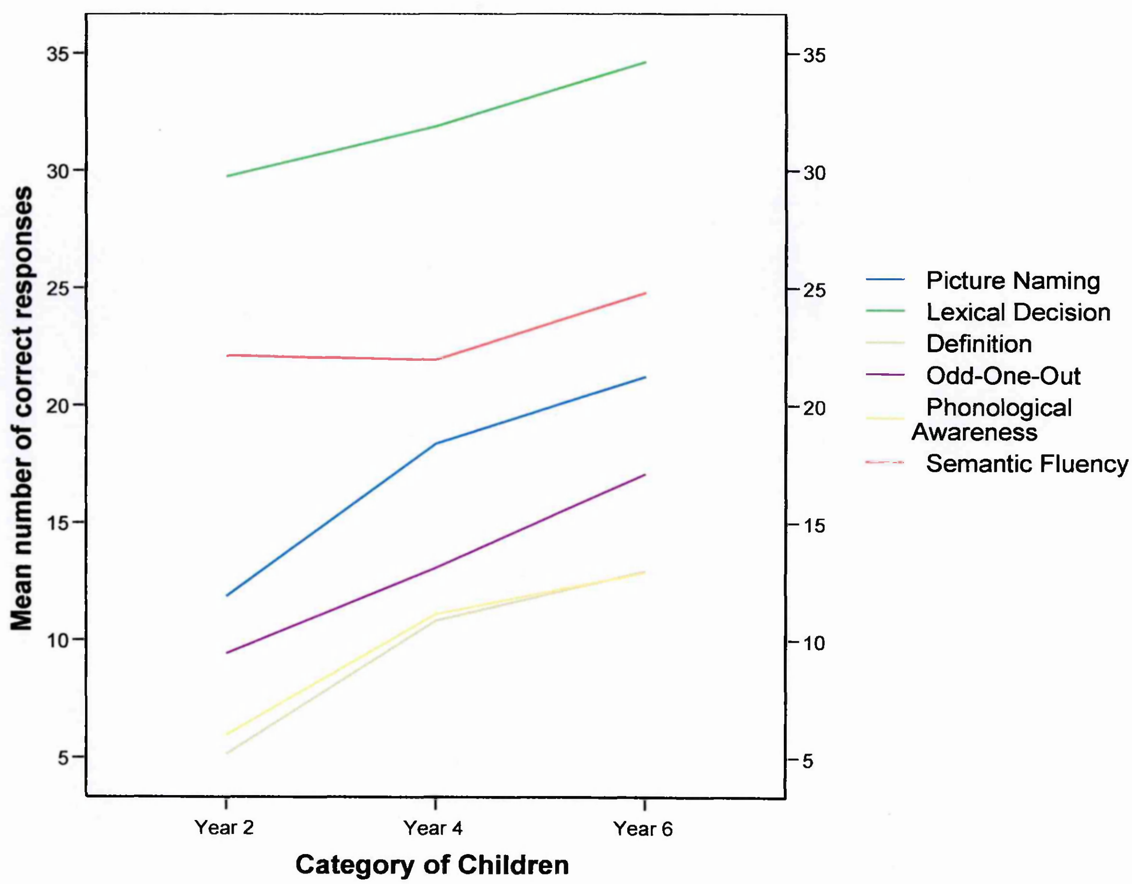
List of Variables	Year 2 [Age: 6-7]	Year 4 [Age: 8-9]	Year 6 [Age: 10-11]	Sig. (2-tail)
NAMING MEASURES				
Picture Naming [n = 30]	11.86 (4.98)	18.37 (5.29)	21.23 (3.82)	$F(2, 99) = 33.406$; $p < .001$ Yr 2 < Yr 4 < Yr 6; $\eta^2 = .403$
BPVS [raw score]	61.25 (9.49)	86.60 (9.01)	101.86 (9.55)	$F(2, 99) = 169.822$; $p < .001$ Yr 2 < Yr 4 < Yr 6; $\eta^2 = .774$
PHONOLOGICAL ABILITY				
Lexical Decision [n = 40]	29.74 (3.47)	31.89 (3.22)	34.63 (2.32)	$F(2, 99) = 21.241$; $p < .001$ Yr2 < Yr4 < Yr6; $\eta^2 = .300$
Phon. Awareness [n = 31]	6.96 (3.29)	11.11 (2.81)	12.89 (2.37)	$F(2, 99) = 50.081$; $p < .001$ Yr2 < Yr4 < Yr6; $\eta^2 = .503$
SEMANTIC ABILITY				
Definition [variable]	5.14 (2.08)	10.83 (3.52)	12.94 (5.01)	$F(2, 99) = 36.455$; $p < .001$ Yr2 < (Yr4 = Yr6); $\eta^2 = .424$
Fluency [variable]	22.11 (5.60)	21.94 (5.25)	24.80 (4.99)	$F(2, 99) = 2.160$; $p = .121$
Categorisation [n = 44]	32.63 (3.82)	34.97 (2.64)	36.11 (2.23)	$F(2, 99) = 11.382$; $p < .001$ Yr2 < (Yr4 = Yr6); $\eta^2 = .187$
Odd-one-out [variable]	9.43 (3.98)	13.09 (5.07)	17.09 (7.38)	$F(2, 99) = 14.364$; $p < .001$ Yr2 < Yr4 < Yr6; $\eta^2 = .225$

Effect size: $\eta p^2 < 0.01$ (small effect); $0.01 < \eta p^2 < 0.10$ (medium effect); $\eta p^2 > 0.10$ (large effect)

Because the frequency of correct responses was not comparable across all tasks, it was decided to run a separate 2-way unrelated (i.e. univariate) ANOVA for each of the dependent variables – with age and gender as the fixed factors. Tukey's post-hoc test was used to identify the location of significant differences. As can be seen in Table 1, there were significant increases in the number of correct response across the three ages for most tasks (except for semantic fluency), although a different pattern was observed on the definition and categorisation task (no significant difference between Years 4 and 6). There were also no significant age differences on the semantic fluency task.

There was no main effect of gender on any of these 8 assessments (see Appendix G for summary statistics). A significant interaction between age and gender was observed for the categorisation task [F (2, 99) = 4.348; p = .015; η^2 = .081 (medium effect)]. Further analysis conducted via independent t-tests revealed that age differences between Year 2 and Year 4 were not significant for the girls [t (27) = -1.716; p = .098]; whereas for boys, the lack of significant age differences occurred between Year 2 and Year 6 [t (29) = -1.249; p = .22] and between Year 4 and Year 6 [t (30) = 1.190; p = .243].

Fig. 1: Distribution of scores across the three ages



3.2. Relationship between Measures of Speed and Accuracy

The analyses in this section concern the relationship between speed and accuracy measures of both lexical and non-lexical abilities.

3.2.1. Relation between Accuracy Scores on Language Processing Tasks

The correlations between the accuracy of naming and the accuracy of performance on the tasks designed to assess lexical processing abilities is given in Table 2.

Table 2: Pearson correlation on language assessments for the whole sample (sig. value in brackets)

	Naming	Phonology		Semantics				Vocabulary
	PN	LD	PA	Def.	Flu.	Categ.	Odd.	BPVS
PN	---	.580** (.001)	.706** (.001)	.610** (.001)	.491** (.001)	.580** (.001)	.381** (.001)	.777** (.001)
LD		---	.526** (.001)	.417** (.001)	.243* (.013)	.440** (.001)	.243* (.013)	.594** (.001)
PA			---	.619** (.001)	.331** (.001)	.442** (.001)	.389** (.001)	.714** (.001)
Def.				---	.289** (.003)	.412** (.001)	.627** (.001)	.679** (.001)
Flu.					---	.265** (.006)	.170 (.083)	.337** (.001)
Categ.						---	.201* (.040)	.512** (.001)
Odd.							---	.424** (.001)
BPVS								---

****Correlations significant at the .01 level (2-tailed)**
*** Correlations significant at the .05 level (2-tailed)**
PN = Picture Naming; LD = Lexical Decision; PA = Phonological Awareness; Fu = Fluency; Def. = Definition; Categ. = Category verification; Odd = Odd-one-out.

As can be seen, naming accuracy was significantly related to all the other measures of lexical ability. In addition, all the measures of lexical content (apart from the odd-one-out and fluency tasks) were also strongly, positively, related to one another. Ninety-six percent of the correlations in the table were significant (and 74% of the significant correlations $\geq .40$). This is not unduly surprising, as one would expect tasks tapping into language abilities to share similar processes.

Also of note, there was a strong inter-relationship between the two measures of phonological ability (lexical decision and phonological awareness), suggesting that these two tasks involved related cognitive processes. On the other hand, correlations between measures of semantic ability were slightly lower (r between .3 and .6). On the other hand, correlations between measures of semantic ability were slightly lower (r between .3 and .6). Looking at the semantic tasks, one notes that the correlations involving definitions and categorisation (with $r = .55$ and .43 respectively for the definition and categorisation were higher than those involving the fluency or odd-one-out (with $r = .34$ on average for these tasks). This seems to indicate that the odd-one-out and fluency tasks were not sensitive measures of semantics, or that these assessments tapped into different components of the semantic system from definitions and categorisation. It is also worth noting that Bonferroni adjustments (with the number of tests equal to 28) identify the significance level as $p < 0.001$. Thus, one should be cautious when interpreting the significance levels in Table 2.

3.2.2. Relation between Accuracy and Response Time on Measures of Lexical Ability

Correlations were calculated between the accuracy of responding on tasks assessing lexical abilities and the speed of response on these tasks (this was only available for some of the tasks).

Table 3: Pearson correlations between speed and accuracy measures (sig. value in brackets) for the whole sample (N = 105). Only significant correlations included.

ACCURACY	**SPEED OF RESPONSE**					
	NAMING		PHONOLOGY	SEMANTICS		
	PN	RAN	LD	Def.	Categ.	Odd
Picture Naming	-.566** (.001)	-.647** (.001)	-.300** (.002)	-.352** (.001)	-.480** (.001)	---
Lexical Decision	-.388** (.001)	-.626** (.001)	-.301** (.002)	-.310** (.001)	-.418** (.001)	---
Phon. Awareness	-.380** (.001)	-.674** (.001)	-.233* (.017)	-.371** (.001)	-.520** (.001)	---
Definition	-.431** (.001)	-.638** (.001)	-.280** (.004)	-.229* (.019)	-.604** (.001)	---
Fluency	-.307** (.001)	-.347** (.001)	---	---	---	---
Categorisation	-.316** (.001)	-.439** (.001)	-.241* (.013)	---	-.309** (.001)	---
Odd-one-out	-.431** (.001)	-.469** (.001)	---	---	-.275** (.005)	---
BPVS	-.497** (.001)	-.785** (.001)	-.402** (.001)	-.370** (.001)	-.677** (.001)	---

****Correlations significant at the .01 level (2-tailed)**
*** Correlations significant at the .05 level (2-tailed)**

Table 3 showed that overall, 71% percent of these correlations were significant (and 47% of the significant correlations were ≥ .40). Several patterns are apparent. First, the relationship between speed and accuracy variables was negative, suggesting that children who are more accurate also tend to be faster when processing lexical stimuli. Strong correlations were also observed between the measure of vocabulary (BPVS) and all other speeds of response, indicating that children who possessed a larger receptive vocabulary tended to be faster at responding on semantic and phonological tasks. Also of interest is the fact that overall, the correlations between speed and accuracy measures were lower than the correlations between accuracy measures (see previous section 3.2.1.), thereby suggesting that speed and accuracy of lexical tasks seem to involve different cognitive processes. However, it should be noted that a Bonferroni adjustment (with the number of tests equal to 48) identified the significance level as $p < .001$ and so there is need for caution when interpreting these findings.

3.2.3. Relation between Accuracy on Lexical Tasks and Speed on Non-Lexical Tasks

Table 4: Pearson correlations (sig. value in brackets) between accuracy scores and speed of response on non-lexical tasks for the whole sample (N = 105). Only significant associations included.

	MEASURES OF NON-LEXICAL ABILITY (Response times in milliseconds)		
	Repetitive Tapping	Simple Motor	Choice Motor
Picture Naming [Acc]	-.602** (.001)	-.584** (.001)	-.462** (.001)
Lexical Decision [Acc]	-.418** (.001)	-.492** (.001)	-.381** (.001)
Phonological Awareness [Acc]	-.659** (.001)	-.601** (.001)	-.526** (.001)
Definition [Acc]	-.532** (.001)	-.527** (.001)	-.555** (.001)
Fluency [Acc]	-.231* (.001)	---	---
Categorisation [Acc]	-.506** (.001)	-.394** (.001)	-.319** (.001)
Odd-one-out [Acc]	-.333** (.001)	-.378** (.001)	-.433** (.001)
BPVS [raw]	-.716** (.001)	-.696** (.001)	-.664** (.001)

****Correlations significant at the .01 level (2-tailed)**
*** Correlations significant at the .05 level (2-tailed)**

The relationship between speed of response on non-lexical tasks and accuracy of language assessments was negative, thereby indicating that children who were faster at responding to non-lexical stimuli were also more accurate on the range of naming, phonological and semantic tasks. Ninety-two percent of the correlations were significant (and 68% of the significant correlations were $\geq .40$). The correlations between non-lexical reaction times and accuracy on tasks related to lexical ability were higher than the inter-correlations between the accuracy variables (see Table 2), but also higher than correlations between speed and accuracy of lexical processing (see Table 3). All correlations remained significant even after Bonferroni adjustments (which set the probability level at $p < 0.002$).

3.3. Predictors of Naming Speed and Accuracy

The three dependent variables (DV) were the speed of discrete naming [DV1], the speed of serial naming [DV2] and the accuracy of discrete naming [DV3]. The accuracy of serial naming was not included as a dependent variable because of ceiling effects. Analyses are presented in two stages: first, correlations between variables related to lexical ability and each of the dependent variables. Second, hierarchical multiple regression analyses were carried out so as to identify the predictors of each of the DVs. The selection of independent variables (IVs) was based on the criteria mentioned in Chapter III so as to have a maximum of 7 IVs. In order to control for the effect of age, this variable was entered in a first block for all the analyses.

3.3.1. Accuracy Variables Predicting Accuracy of Discrete Naming

Table 5: Pearson correlations between naming accuracy and the accuracy on other measures of lexical ability (sig. value in brackets)

Accuracy variables (IVs)	**DV3 Picture Naming [Acc]**
BPVS	.777** (.001)
Lexical Decision	.580** (.001)
Phonological awareness	.706** (.001)
Fluency	.491** (.001)
Categorisation	.580** (.001)
Definition	.610** (.001)
Odd-One-Out	.381** (.001)
Age	.650** (.001)

****Correlations significant at the .01 level (2-tailed)**
***Correlations significant at the .05 level (2-tailed)**

Table 5 shows that the accuracy performance on all the phonological and semantic tasks had high and significant correlations with the accuracy of discrete naming (average of r = .60). Based on this, the variables entered in the regression equation were: age in a first block and then in a second block, raw scores on the BPVS together with scores on the lexical decision, phonological awareness, semantic fluency, categorisation and definition.

The output from the regression analysis (summarised in Table 6 below) showed that age, entered first, explained a significant percentage of the variance (39%) in discrete naming accuracy [F (1, 103) = 67.116; p < .001]. When lexical factors were entered second, these explained an additional – significant – 33% of the variance [F (6, 97) = 21.791; p < .001]. As summarised in Table 6 below, 5 main predictors were identified in relation to the accuracy of discrete naming: age (p = .050); scores on the BPVS (p < .001); scores on the measure of phonological awareness (p < .005); scores on the semantic fluency (p < .005) and scores on the categorisation task (p < .005).

Table 6: Identification of the accuracy predictors of discrete naming accuracy

Blocks		β	Standard error β	Beta	Sig. (2-tailed)
Block 1					
	Age	-1.627	.821	-.218	.050
Block 2: [Lexical tasks]					
	BPVS	.170	.038	.533	< .001
	Lexical decision	.182	.112	.108	NS
	Phonological awareness	.361	.120	.241	.003
	Fluency	.208	.065	.184	.002
	Categorisation	.316	.115	.170	.007
	Definition	.087	.091	.071	NS

NS: non-significant

3.3.2. Response Time Variables Predicting Accuracy of Discrete Naming

Table 7: Pearson correlations between accuracy of naming and other measures of speed of response (sig. value in brackets)

Type of ability	Response time variables (IVs)	DV3 Picture Naming [Acc]
LEXICAL ABILITIES	Lexical Decision	-.300** (.002)
	Categorisation	-.480** (.001)
	Definition	-.352** (.001)
	Odd-One-Out	-.180 (.067)
NON-LEXICAL ABILITIES	Counter pressing	-.602** (.001)
	Simple Motor	-.584** (.001)
	Choice Motor	-.462** (.001)
	Age	.650** (.001)

****Correlations significant at the .01 level (2-tailed) // **Correlations significant at the .05 level (2-tailed)**

Table 7 showed that the response times for all the semantic, phonological and non-lexical tasks were correlated with naming accuracy, with the exception of the semantic odd-one-out task. A particularly interesting finding was that the speed of response on non-lexical tasks was more strongly related with the DV than speeds of response on the lexical assessments.

A hierarchical multiple regression analysis was conducted to determine the relative contribution of age, response times on lexical tasks (i.e. measures of semantic and phonological ability) and response speed on non-lexical tasks to discrete naming accuracy. Age was entered in the first block to account for general maturational changes. Speeds of response on the lexical tasks (i.e. categorisation, lexical decision and definition) were entered in a second block. Speeds of motor response (tapping, simple and choice motor) were entered in a third block. A second model was tested whereby age remained in the first block but speed of response on the non-lexical tasks were entered in a second block and speeds of response on the lexical measures were entered in a third block. The same pattern of results was obtained on both models. Therefore, findings only of model 1 are presented.

Age, entered first, explained a significant percentage (39%) of the variance in discrete naming accuracy [$F(1, 103) = 67.116$; $p < .001$]. Speed of response on the lexical tasks when entered second, failed to account for a significant portion of the variance [$F(3, 100) = .472$; $p = .702$]. Finally, speed of response on the non-lexical factors was a significant predictor and accounted for a further 6% of the variance in discrete naming accuracy [$F(3, 97) = 5.075$; $p = .003$]. As summarised by Table 8, three main predictors were identified in relation to discrete naming accuracy: age ($p = .006$); speed of response on the counter pressing task ($p = .009$) and speed of response on the simple motor task ($p = .032$).

Table 8: Identification of the predictors of discrete naming accuracy from speed of response tasks

Blocks		β	Standard error β	Beta	Sig. (2-tailed)
Block 1					
	Age	2.731	.977	.366	.006
Block 2: [Lexical tasks]					
	Categorisation	.003	.004	.070	NS
	Definition	.000	.001	-.067	NS
	Lexical Decision	-.002	.003	-.068	NS
Block 3 [Non-lexical tasks]					
	Counter task	-.033	.012	-.286	.009
	Simple motor	-.017	.008	-.262	.032
	Choice motor	.006	.004	.177	NS

NS: Non Significant

3.3.3. Accuracy and the Prediction of Discrete and Serial Naming Speeds

Inspection of Table 9 showed that correlations of the measures of lexical abilities with serial naming speed were stronger than with discrete naming speed. Overall, correlations with serial naming speed were around $r = .57$ whereas correlations with discrete naming speed averaged $r = .39$.

Table 9: Pearson correlations between naming speeds and accuracy of response on other measures of lexical ability (sig. value in brackets)

Accuracy variables (IVs)	**DV1 Picture Naming [RT]**	**DV2 Rapid Automatized Naming [RT]**
BPVS	-.497** (.001)	-.785** (.001)
Lexical Decision	-.388** (.001)	-.626** (.001)
Phonological awareness	-.380** (.001)	-.674** (.001)
Fluency	-.307** (.001)	-.347** (.001)
Categorisation	-.316** (.001)	-.439** (.001)
Definition	-.431** (.001)	-.638** (.001)
Odd-One-Out	-.431** (.001)	-.469** (.001)
Age	-.407** (.001)	-.799** (.001)

****Correlations significant at the .01 level (2-tailed)**
***Correlations significant at the .05 level (2-tailed)**

3.3.3.1. Prediction of Discrete Naming Speed from Accuracy Variables

The following 7 IVs were entered in the regression equation: age in a first block and in a second block scores on the BPVS, definition, odd-one-out, lexical decision, phonological awareness and categorisation tasks. The output of the regression analysis (see Table 10) showed that age explained a significant portion (14%) of the variance of discrete naming speed [$F(1, 103) = 18.023$; $p < .001$]. Accuracy of response on the lexical factors explained a further 17% of the variance [$F(6, 97) = 6.094$; $p < .001$].

Table 10: Identification of the accuracy predictors of discrete naming speed

Blocks		β	Standard error β	Beta	Sig. (2-tailed)
Block 1					
	Age	98.201	47.084	.363	.040
Block 2: [Lexical tasks]					
	BPVS	-6.338	2.165	-.549	.004
	Definition	.357	5.968	.008	NS
	Odd-one-out	-11.315	3.731	-.328	.003
	Lexical Decision	-9.558	6.442	-.156	NS
	Phonological awareness	-.579	6.805	-.011	NS
	Categorisation	-3.799	6.621	-.056	NS

NS: Non Significant

3.3.3.2. Prediction of Serial Naming Speed from Accuracy Variables

Seven variables were entered in the regression equation. These were: age in a first block and in a second block accuracy on the BPVS, phonological awareness, lexical decision, definition, categorisation, and odd-one-out tasks. The output from the hierarchical regression analysis (summarised in Table 11) showed that age made a significant contribution (61%) to serial naming speed [F (1, 103) = 164. 189; p < .001]. Accuracy of response on lexical factors explained an incremental 8% of the variance [F (6, 97) = 5.482; p < .001]. As summarised by Table 11, 2 main predictors were identified: age (p = .013) and accuracy on the lexical decision task (p = .003).

Table 11: Identification of the accuracy predictors of serial naming speed

Blocks	β	Standard error β	Beta	Sig. (2-tailed)
Block 1				
Age	-69.327	27.395	-.294	.013
Block 2: [Lexical tasks]				
BPVS	-2.412	1.259	-.239	.058
Lexical decision	-11..349	3.748	-.213	.003
Phonological awareness	-4.997	3.959	-.105	NS
Definition	-3.224	3.472	-.083	NS
Categorisation	.061	3.852	.001	NS
Odd-one-out	-2.390	2.171	-.079	NS

NS: Non Significant

IV. DISCUSSION

Three key issues are addressed: role of participant variables across the range of lexical and non-lexical abilities; relation between speed and accuracy of response on both language and non-language tasks; and finally, identification of the main predictors of naming.

4.1. Age and Gender in relation to Accuracy of Responses

Previous findings about the language ability of girls and boys have not provided a consistent picture about the presence of gender differences. As discussed earlier, some research showed gender effects for pre-school children (Bornstein et al., 2004; Huttenlocher et al., 1991) whereas other researchers found that girls outperformed boys throughout the academic years (Duckworth & Seligman, 2006; Landgren et al., 2003). However, no significant differences were obtained in the current research when comparing the accuracy of responses on naming and other language tasks (see Appendix G). These results seem to support previous work (Bornstein et al., 2004; Gleason, 2002) stating that gender differences are no longer observed beyond age 5. However, one should exercise caution in interpreting these findings as differences between studies and samples might explain the lack of gender effect. In particular, as discussed in Chapter III, the lack of significance might be due to the sample size.

In contrast to the lack of gender effect, a main effect of age was observed across most of the tasks, thereby corroborating previous findings (Fried-Oken, 1982; Vance et al., 2005; Wiegel-Crump & Dennis, 1986). In relation to the discrete naming task, the current results are consistent with, for example, work from Troia & Roth (1996) who assessed the speed and accuracy of typical kindergarten and Grade 2 (7-8 year old) children on measures of serial and confrontational naming. The authors reported higher levels of accuracy in the older children. However, not all studies have identified increases in naming accuracy with increasing age (see Leonard et al., 1983 – with 6 to 13 year old children with LI; Vance et al., 2005). Vance and colleagues administered a discrete naming task to 100 typical 3 to 7 year olds. Although the authors found a main effect of age, their findings showed that gains in naming accuracy levelled off by the age of 5-6. Vance and colleagues concluded that most children by the age of 5 or 6 had already acquired an adult (or so-called *mature*) phonological system, thereby explaining the lack of significant increase (Grunwell, 1987). These differences between studies might stem from the use of different testing procedures or selection of the samples – for example, Vance et al. assessed the accuracy of a limited set of reasonably simple items, whereas in this sample some items were selected to present difficulties for the older children.

A similar pattern was obtained on measures of vocabulary, odd-one-out and phonology (lexical decision and phonological awareness) which showed significant increases across all three ages. The latter finding might provide further evidence that children have not yet reached an adult phonological system (unlike what Vance claimed). However, there was no significant age-related difference on the semantic fluency task; and for the categorisation and definition tasks, Year 2 children were less accurate than children at the two other ages.

4.2. Relationships between Speed and Accuracy

One of the reasons for looking at the relationship between speed and accuracy variables was to determine whether a trade-off could be observed at particular ages. A second rationale was to determine which of these variables predicted speed or accuracy of naming (this key issue is also taken up further in section 4.3.). Three main sets of findings were obtained.

Bivariate correlations between tasks assessing the accuracy of lexical abilities showed moderate to strong inter-relations (between .20 and .619). One of the dependent variables of the study, i.e. discrete naming accuracy was also strongly related to accuracy scores on the measures of semantics and phonology (between .381 and .706). These findings suggest that if a child possessed more accurate information about one aspect of the lexical system, the child would be more likely to have accurate information about other aspects of the lexical system and to be more accurate at naming (see Table 2).

Another set of correlational analyses between the speed and accuracy variables of tasks assessing lexical abilities failed to show the presence of a trade-off. Indeed, the negative correlations between speed and accuracy indicate that the faster children also tended to be more accurate (see Table 3). This finding differs from, for example, Brewer & Smith (1989)'s study, which showed that a trade-off operates until age 9 (they used a sample of 5, 7, 9 and 11 year olds) when assessed on non-linguistic reaction time tasks. The findings from the current study are consistent with the explanation that as children become faster at processing information, this frees up cognitive resources so they are also 'better' at these tasks, thereby enabling gains in terms of accuracy (Salthouse, 1996).

Finally there was the issue, partly addressed in chapter III, concerning the relationship between children's scores on the language-based tests and children's speed of response on non-lexical tasks. High correlations were obtained between accuracy of discrete naming and speed of response on non-lexical tasks (between .462 and .602). Likewise, moderate to high correlations were obtained between accuracy on tasks tapping into semantics, phonology and comprehension vocabulary and the speed of response on non-lexical tasks (between .231 and .716). In addition, the current data (see Table 4) revealed an interesting pattern in that, overall, the relationship between general speed of information processing and accuracy was higher than (a) the correlations observed between accuracy variables themselves and higher than (b) the correlations between speed and accuracy on lexical tasks (see section 3.2.). Such results mean that it is unlikely that lexical abilities are responsible for the relationship between non-lexical processing speed and accuracy variables. These findings are in line with, for example, Kail & Miller's (2006; but see also Miller, Franz & Ulrich, 1999; Miller, Kail, Leonard & Tomblin, 2001) investigation of 9 and 14 year old children with SLI and typical controls. The authors found strong correlations between children's performance on language-based tasks and speed of response on tasks involving non-lexical stimuli (with correlations of .43 at age 9 and .59 at age 14 – which are similar to the correlation obtained in the current study of $r = .50$). Although these findings can be contrasted with those of Lahey et al. (2001) who failed to find significant correlations between processing speed and language performance (only 4 out of 40 correlations were significant, with $r = .28$ on average). Possible reasons for the difference between these studies might reside in the limited number of dimensions used by Lahey or their young sample (mean age of 6:09) or the fact that they mainly used standardised language tests.

In summary: The present findings reinforce the suggestion that basic processing abilities are integral to efficient language development and language use. In addition, the results support Kail's assumption that a general processing factor underlies the speed of performance on lexical and non-lexical tasks (Kail, 1994; Nicolson & Fawcett, 1999; Wolf, Bowers & Biddle, 2004). As such, speed of information processing is likely to impact on children's speed or accuracy of naming. This issue will be taken up further in the next section looking at predictors of naming speed and accuracy.

4.3. Identification of the Predictors of Naming Speed and Accuracy

Table 12 presents a summary about the predictors of naming. Interpretations of these findings are discussed below. As in Chapter III, multiple regression analyses serve to emphasise the fact that serial and discrete naming are determined by different sets of processes or abilities.

Table 12: Recap: The significant predictors from the hierarchical multiple regression analyses

Independent Variables	**DEPENDENT VARIABLES**		
	Discrete naming Speed	**Serial naming speed**	**Discrete naming accuracy**
Speed variables	Age [see Chapter III]	Age Simple Motor & Counter tapping [see Chapter III]	Age Counter tapping & Simple motor
Accuracy variables	BPVS	Age Lexical Decision	Age BPVS Fluency Categorisation Phon. awareness

CHAPTER IV: Accuracy of Naming

Predictors of Serial Naming

Age was the most important predictor of serial naming speed, which is consistent with findings about atypical children that the RAN is related to development and maturation (Denckla & Cutting, 1999). The current findings also showed that serial naming speed was predicted by accuracy on the lexical decision task thereby highlighting the importance of phonology - as suggested by previous researchers (Catts, Adolf, Hogan & Ellis-Weismer, 2005; Schatschneider, Carlson & Francis, 2002; Truman & Hennessey, 2006). Surprisingly, measures of semantic ability did not contribute significantly to serial naming speed. Because speed of response to non-lexical tasks were also identified as important predictors, the current findings also support the idea that the RAN assesses the lower-level, automatic processes (Logan 1988; Manis et al. 1999; Wolf, 1991; Wolf & Bowers, 1999; Wolf et al., 2000).

Predictors of Discrete Naming

Analysis of the predictors of speed and accuracy of discrete naming (see summary Table 12) showed the importance of development and maturation, a finding reported in a number of other investigations (Cunningham, 2005; Bloom, 2000a & b; Vance et al., 2005). In addition, the results indicate that discrete naming accuracy was more dependent on a range of semantic and phonological abilities (Goodglass, 1998; Levelt et al., 1999). This can be seen by a comparison of the predictors of these two variables (see Table 12). Indeed, the current findings are in agreement with suggestions that confrontation naming involves access to a more elaborate knowledge base to retrieve the name of a picture (or vocabulary knowledge) than serial naming, and also shows the importance of conscious awareness of the content of a lexical item (see Wolf & Obregon, 1992). In other words, the current analysis indicated that faster speed of discrete naming was associated with a more elaborate knowledge base. This latter finding corroborates, for example, the work of Walker, Barrow & Rastatter (2002) on typical children. Indeed, Walker and colleagues examined typical children on a confrontational naming task by presenting words from two different levels of vocabulary age (5 and 9.5-10 years). Findings indicated that naming times were dependent on the extent of children's vocabulary. The importance of semantic abilities found in this research is also in line with previous work emphasising the importance of semantic representations to the discrete naming process (Lahey & Edwards, 1999; Leonard, 1998; McGregor et al., 2002).

More importantly, it is worth commenting on the fact that speeds of response on non-lexical tasks made separate and independent contributions to discrete naming accuracy. These findings emphasise Kail's claims that speed of information processing is related to language ability (e.g. Kail & Miller, 2006). The implication for research is that naming, even for typical children, is dependent on how fast children are on motor tasks. This fits in with the assumption that language in general, and naming in particular, is linked to the availability and accessibility of lexical representations but also, is reliant on general speed of information processing. The suggestion that general speed of information processing capacity is linked to *language status* (or ability) is consistent with Kail's (1994; 1999; Kail & Miller, 2006) general information processing approach (see also Bishop and Edmundson, 1987; Hill, 2001).

V. CONCLUSION

Significant increases were observed in accuracy across lexical and non-lexical tasks in relation to age. However, no significant gender differences were observed. Strong correlations were obtained between accuracy scores on the lexical tasks thereby illustrating the assumption that the lexical system is integrated. Speed and accuracy variables were negatively correlated, therefore suggesting that children who can access the content of the lexicon accurately tend to be subsequently faster at processing lexical stimuli. The analysis of predictors of speed and accuracy of naming further confirmed that these two forms of naming involve different processes. Whereas serial naming was more reliant on automatic processing speed, discrete naming speed was related to general ability and vocabulary size. Moreover, speed of processing on non-lexical tasks was also identified as making separate and independent contributions to discrete naming accuracy. These findings have implications in terms of the development of naming models, as it seems that for typical children, and unlike what has been found in some language disabilities - the integrity of both semantic and phonological systems is a prerequisite for efficient naming. Future work could build on the present data, by implementing a longitudinal rather than cross-sectional investigation to contribute further to the understanding of children's naming difficulties.

CHAPTER V

PATTERN OF NAMING ERRORS IN CHILDREN WITH WFDs AND IN TYPICAL CHILDREN

I. INTRODUCTION

An issue addressed in the previous chapters concerned the importance of semantic and phonological knowledge in relation to word production in typical children. The types of errors children make during naming are believed to reflect the locus of impairment (Dell 1990; Dell, Reed, Adams & Meyer, 2000; Levelt et al., 1999). For example, studies of children with literacy difficulties indicate that phonological errors are more common than in typical children and this group are known to have impairments to their phonological system (Swan & Goswami, 1987a & b; Truman & Hennessey, 2006; Vukovic et al., 2004); while studies of poor comprehenders indicate that there are more semantic errors compared to typical children and this group are known to have difficulties with semantic information (Nation & Snowling, 1998a; 2000; 2004). In both cases, the investigators have suggested that phonological or semantic representations are impaired, and this is the cause of the naming errors. However, limitations to this approach have been raised (see Butterworth, 1989 for review; Messer & Dockrell, 2006b). For instance, several researchers have shown that associated phonological forms could be activated when there is a failure to identify a relevant semantic form (Hillis, 1990; Gershkoff-Stowe, 1997; Hoek, Ingram & Gibson, 1986; McGregor, 1994; 1997). Nevertheless, error analysis can provide a useful source of information about naming processes which can help to identify the locus of word production difficulties.

CHAPTER V: Pattern of Naming Errors

There have been comparatively few studies of naming errors in typical children with much of the research interest being focused on atypical development. For example, McGregor (1997) examined preschool children with WFDs and their chronological-age controls on two subscales of the TWF (naming objects and naming actions). Interestingly, her findings showed a similar profile of errors for both groups of children. Specifically, semantic errors were more common than phonological errors and unrelated errors (i.e. "*don't know*" responses) were the least common. Similar findings have been reported by Dockrell, Messer & George (2001) investigating school age children with WFDs and their age- and language-age typical peers. These authors found that semantic errors were the more frequent type of errors for all children. In addition, there was no significant difference in the proportion of semantic errors for typical and WF samples (see also Messer & Dockrell, 2006a for review). These studies therefore highlight the possible role of semantic representations in relation to naming accuracy.

The methods used in the current investigation were based on McGregor's study (1997) of children with WFDs. The children were assessed on two standardised tasks taken from the Test of Word Finding where children were asked to name concrete objects (i.e. nouns) and action targets (i.e. verbs). Children with WFDs aged between 3 and 5 years made significantly more errors than chronological age matched typical peers. The majority of picture naming errors bore a semantic relation to their target, which implicated the *lemma* as the primary focus of word-finding deficits. It was decided to extend McGregor's study by using an older age range of typical children and thus assess whether a similar pattern of errors could be observed for different ages.

CHAPTER V: Pattern of Naming Errors

When this investigation was being planned data from another research project concerning children with word finding difficulties (WFDs) were available, and consequently it was decided to carry out the study so naming errors in typical children could be obtained and comparisons could be made involving children with WFDs (see Methods chapter for details of participants and assessments used). Unlike McGregor, who used a clinical assessment, the selection of the WFD sample was based on a standardised test, German's Test of Word Finding (TWF; German, 1989). The TWF is the most widely used assessment for identifying children who have naming difficulties. The typical children in the current research were either of similar chronological age to the children with WFDs or had similar comprehension skills. In this respect the design of the study was similar to that conducted by Dockrell and colleagues (2003). Their comparison groups consisted of a chronological age group, a naming age group (where children were matched on productive vocabulary scale of the British Ability Scale; BAS) and a language age group (where children were matched on their syntactic comprehension; Test of Reception of Grammar, TROG). Semantic errors were the most common for all groups of children when naming objects. However, children with WFDs made proportionately more phonological errors. There was a lack of significant difference in either frequency or proportion of errors in relation to verb naming. In the current research, it was decided to match on children's receptive vocabulary. One reason for matching on this dimension was to provide further insight about the range of data we have about the WFD population. Also, receptive vocabulary appears to be a language ability which is neither a particular strength nor a particular weakness in children with WFDs (Messer, Dockrell & Murphy, 2005).

The role of lexical factors in relation to naming errors was also investigated in order to add to the existing knowledge about lexical retrieval. Research concerning adult word production

(Dirks, Takayanagi, Moshfegh, Noffsinger & Fausti, 2001; Luce & Pisoni, 1998) has shown that specific lexical factors influence the speed and the accuracy of lexical access. These lexical factors include word frequency (Forster & Chambers, 1973; Vitevitch, 2002; Vitevitch & Sommers, 2003), age of acquisition (Barry, Hirsh, Johnston & Williams, 2001; Carroll & White, 1973a & b; Morrison, Ellis & Quinlan, 1992), variables such as word length (Katz, 1986; Morrison et al., 1992; Paivio et al., 1989) or lexical neighbourhood factors which represent the number or frequency of phonological or orthographic neighbours that a target word has (Harley & Brown, 1998; Newman & German, 2002; 2004).

The role of lexical factors in children's naming has rarely been investigated (Faust et al., 1997; Storkel, 2002; Walley & Metsala, 1992). One exception is provided by a recent investigation by German & Newman (2004; see also Newman & German, 2002) concerning the relationship between 4 lexical factors (i.e. word frequency, age of acquisition, familiarity and lexical neighbourhood) and children's naming errors. Correlations and stepwise regression analyses (with each of these errors as the dependent variable and the lexical factors as the independent variables) were conducted to determine whether significant predictors could be identified for each type of errors. No significant factor was identified as predictor(s) for the semantic error pattern. In contrast, frequency ($r = -.29$; $p = .006$) and neighbourhood frequency ($r = -.34$; $p = .001$) were identified as predictors of phonological errors for children with WFDs. It was decided to take German and Newman's analysis further by examining lexical characteristics involving word frequency, age of acquisition, familiarity, neighbourhood density and neighbourhood frequency in relation to naming errors. Conclusions will be drawn as to the importance of these lexical factors to lexical access in typical and atypical samples.

CHAPTER V: Pattern of Naming Errors

Research Questions

The current study will address each of the following issues:

1. What are the types of errors made when naming objects and actions by typical children and children with WFDs?

2. Are there differences between typical children and children with WFDs in the nature of their naming errors?

3. Can the incidence of naming errors be explained by the characteristics of the target words to be named?

II. METHODOLOGY

2.1. Participants and Test Materials

Table 1: Characteristic of typical and word-finding participants

	COMPARISON GROUPS		
	WFD	**LA**	**CA**
Number of participants	N = 20	N = 20	N = 20
Gender	14 Boys & 6 Girls	14 Boys & 6 Girls	10 Boys & 10 Girls
Age range	[6:04 – 7:10]	[4:01 – 7:06]	[6:03 – 7:06]
Average age	[07:01]	[05:10]	[07:00]

The *WFD sample* was obtained through an earlier study conducted by Murphy (see study by Messer, Dockrell & Murphy, 2004). These children were recruited from special language units attached to mainstream schools in the London region. At the time of the study, all children were undergoing speech and language therapy. Prior to being included in the study, they were screened on a number of objective measures to establish their suitability to be part of the WFD group. Thus: (a) children had to score at least one standard deviation below the mean on the Test of Word Finding (TWF; German, 1989); (b) children had to score at least at the 20th percentile on a measure of non-verbal intelligence (Progressive Coloured Matrices test; Raven, Court & Raven, 1983); (c) children had to perform within the normal range on the Edinburgh Articulation Test (Anthony, Bogle, Ingram & McIsaac, 1971). Details of these and other standardised tests are provided in Table 2.

Table 2: List of assessments used to assess children's naming skills and receptive vocabulary

Battery of tasks used to verify suitability of participants for inclusion in the WFD group	**Description**
Test of Word Finding (TWF; German, 1989)	Naming a series of coloured plates depicting concrete objects as well as actions. Standardised measure designed to identify word finding difficulties.
Progressive Coloured Matrices (Raven et al. 1982)	Measure of non-verbal intelligence. Children instructed to identify the relationship between different patterns and choose the missing piece from each given pattern.
Edinburgh Articulation Test (EAT; Anthony et al., 1971)	Measure of children's articulation skills. Participants were instructed to name pictures of common nouns where the consonant sounds occupied various positions in any given word.
Additional assessments for both typical and WF samples	
Test of Word Finding (TWF; German, 1989)	The children's picture naming was assessed on the object and action subscales of German's TWF (1989).
British Picture Vocabulary Scale (BPVS-II; Dunn et al., 1992)	Used as a measure of receptive vocabulary. The task required children to point to the picture (among a set of 4) that best matched the word spoken by the experimenter.

The WFD sample (N = 20) was matched with 2 typical control comparison groups: a chronological age group (CA) and a language age (LA) group. Four children served as 'double matches' (i.e. both a CA- and a LA-match). Typical children were recruited from mainstream schools in the SE London area. A number of precautions were implemented in selecting the typical peers: it was decided to select only those children having (standardised) scores of above 85 on the BPVS, so as to ensure their vocabulary skills were within the normal range. As recommended by Dockrell et al. (2001), the LA children did not differ by more than 3 months to their corresponding match.

LA matches. The language age controls included 20 children who were individually matched to the WFD group so that each typical child had a raw score within +/- 4 points of a child with WFDs on the measure of receptive vocabulary (i.e. BPVS). The sample comprised 6 second-graders, 7 first-graders and 7 reception children. The difference between the age equivalent scores from the BPVS of the WFDs and of the LA group was a mean of 2 months (SD = .006).

CA matches. The chronological age sample comprised 20 children who were also each individually matched to a child from the WFD group so that each typical child had a CA within +/- 4 weeks of a child in the WFD group. This group comprised 16 second-graders and 4 first-graders (see Table 1 for details).

2.2. Procedure

Children were introduced to the experimenter by the class teacher and assessed individually in a quiet environment on the school premises. Whereas the WFD sample were assessed on all components of the TWF as part of the original study of Murphy (see Messer et al. 2004), typical children's naming ability was assessed solely on concrete objects (i.e. nouns) and action events (i.e. verbs). Sessions lasted approximately 45 minutes for the WFD group and 25 minutes for the typical controls.

2.3. Coding of Word Error Substitutions

The nature of children's errors was analysed by use of a coding frame designed to capture the full range of children's responses. There is a methodological issue about coding errors due to the difficulty of ascertaining the exact nature of the relation between target word and the word produced incorrectly. Although there is an error coding scheme published by McGregor (1997), it was difficult to determine a rationale for the use of certain category labels. It was therefore decided to adopt a more rigorous and systematic approach by including additional categories and/or modify existing ones by use of German's (1989) instruction manual. Children's responses were coded according to four main categories which illustrated the relationship between the target picture and children's word substitutions. Each of these 4 types of errors was further subdivided into several subtypes. The classification of these subtypes originated from work with adult aphasics (Geschwind, 1967; Rochford, 1971; Rinnert & Whittaker, 1973) but have been adapted to the study of child populations (see for example German, 1989; McGregor, 1997). Details of the coding frame used in the current study are presented below.

(A) *Visual errors* were incorrect responses that shared similar perceptual features with the target picture (e.g. saying "*ball*" for "*bead*"). Because German (1989) argued that visual errors occurred prior to the stage of lexical entry, these errors were not representative of word retrieval failures. Thus, although visual errors have been coded as such in the current research, the data has not been used in the subsequent statistical analyses (see Appendix E for coding for visual errors). Of note, visual errors also represented the smallest number of substitutions (9%, 11% and 10% for the WFD, LA and CA samples respectively);

(B) *Semantic errors* – were incorrect responses which shared a similar meaning with the target word (e.g. saying "*tired*" for "*yawn*"). Semantic errors were further coded according to the distinction between taxonomic, thematic or novel compound types of responses.

TAXONOMIC	Code	Target word	Example	Definition
Superordinate	SUP	Domino Juggling	Game Throwing	Substitutions that refer to the semantic class that the target words belong to.
Coordinate	CO	Barrel Curling	Bucket Brushing	Substitutions that are from the same level of inclusion as the target. Both terms are interchangeable in some contexts (like synonyms).
Subordinate	SUB	Planting	Digging	Substitutions that involve words belonging to a lower/inferior aspect of the semantic hierarchical organisation system
THEMATIC				
Association	A	Earphones Yawning	Radio Tired	Terms cannot be substituted for one another, but are related by association
Functional attribute	FA	Handcuffs	Locking	Specifies how to use an object or what one can do with it.
Compositional	COMP	Cactus Cactus	Prickles Sharp	Specifies what the object is made of (material) or adjective specifying the quality of the attribute
Locative attribute	LA	Shelf	Kitchen	Specifies a possible location of the target word.
Circumlocution	C	Curling	Doing her hair	Use of a sentence rather than one-word answer
NOVEL COMPOUND				
Innovative Label	IL	Pipe Smoking	Watertap Piping	Use novel word form/turn of phrase tp describe the target word.

(C) *Phonological errors* – were incorrect responses which shared a similar sound structure with the target word (e.g. "*clown*" for "*crown*").

Substitution Category	Code	Target word	Example	Definition
Initial Sound	IS	Barrel Watering	***B***-in W-w-w-	Similar sound only shared at the beginning (onset) of a word
Approximation	A	Crown Juggling	*C*-l-***own*** *J*-i-***ggling***	Share similar sounds (phoneme) both at beginning and end of a word
Part-Whole	PW	Microphone Zipping	Speaker*phone* Put the *zip* up	Similar sound shared at the syllabic level

(D) *Unrelated errors* – were responses indicating that children did not know the target item such as non responses (e.g. "*I don't know*", "*I can't remember*") or incoherent responses (e.g. saying "strunt" for "anchor").

Substitution Category	Code	Target word	Example	Definition
Don't Know	DK			Children specifically state that they do not know or cannot remember the target name
Incoherent Response	IR	Anchor Planting	Strunt Hooving	Comprises responses that are incoherent and/or incorrect, or that do no fit any of the previously defined categories

A few rules were set prior to coding children's responses:

- Following recommended practice when assessing children's productive vocabulary skills, only first responses were recorded.
- Multiple coding was allowed. Thus, if an error involved semantic and phonological similarities to the target, both categories were coded separately e.g. saying "*microphone*(*s*)" for "*earphones*" received both a semantic and a phonological code.
- Likewise, multiple coding was also allowed within each category. For example, saying "*hairy tree*" for "*cactus*" received both coordinate and innovative label codes.

Scorer reliability: All scripts were transcribed and coded after the testing session. In order to establish reliability, a second scorer was provided with a draft of the coding frame – with the different categories, accompanied by description and examples - and randomly coded 21 scripts out of 60 (7 scripts picked randomly from each sample). This resulted in a 76% agreement between both scorers (percentage of agreement for each sample as follows: 80% for the WFD sample, 77% for the CA sample and 70% for the LA samples).

2.4. Identifying the Lexical Characteristics of the Target Words

Four lexical factors were selected. These consist of word frequency, familiarity, lexical neighbourhood characteristics and age-of-acquisition. To date, there is a lack of adequate database for children. It was thus decided to use the available norms, which originate from adult populations. These are summarised in Table 3.

- *Word frequency* norms were taken from the Kucera & Francis (1967) word count. This was accessed via the online version of the MRC Psycholinguistic Database (Wilson, 1988), whereby the maximum frequency is 69971 and the minimum is 0. The higher frequency items are believed to be named faster and more accurately than less frequent labels (Goodglass, Theurkauf & Wingfield, 1984; Luce & Pisoni, 1998).

- *Word familiarity* ratings were taken from the MRC Psycholinguistic database (Wilson, 1988), with values range from 100 to 700. A word's familiarity refers to how common a word is. Highly familiar labels are commonly believed to facilitate word retrieval.

- The number of lexical neighbours of a target word consists of words that sound alike and/or share similar orthographic patterns. There are two types of neighbourhood factors: (A) *Neighbourhood density* (ND), representing the number of words that phonologically resemble the target words (with a maximum of 34) and (B) *Neighbourhood Frequency* (NF), which captures information as to how many neighbours a word has, but also the frequency of usage of those neighbours (maximum of 14). Information on these variables comes from the English Lexicon Project (Balota, Cortese, Hutchinson, Neely, Nelson, Simpson & Treiman, 2002), which is a database providing normative data for 40/80 000 written words. In this respect, dense neighbourhoods are believed to inhibit naming accuracy due to the competition with neighbours sounding alike.

- Age of acquisition (AoA) was taken from Morrisson, Chappell & Ellis' (1997) norms, which provides information both with regards to noun and verb, with the earlier words facilitating word retrieval.

Table 3: Mean and standard deviations of lexical characteristics of target items (norms taken from the English Lexicon Project database; Balota et al., 2002)

	Nouns	**Verbs**	**Standardised norms for 80 000 items from ELP database**
Mean frequency	15.111	6.632	(M = 29.73; SD = 557.64; Range: 1 - 69971)
Mean Neighbourhood Density	4.227	5.050	(M = 1.58; SD = 3.39; Range: 0 – 34)
Mean Neighbourhood Frequency	7.425	4.911	(M = 5.34; SD = 2.44; Range: 0 – 14)
Familiarity	463.312	n/a	n/a
Age of Acquisition	3.42	2.981	n/a

III. RESULTS

The results section is structured into 3 sections. A first section concerns the number of errors made by the three groups. The second section examines whether the proportion of semantic, phonological and/or unrelated errors differed significantly across groups. A final section examines whether the incidence of word finding errors were related to the lexical characteristic of the target words.

3.1. Frequency of Errors: Nouns and Verbs

It was decided to transform the number of errors for objects so that children's scores would be comparable across nouns and verbs. To obtain this adjusted frequency of errors for objects the formula used was: [total errors on object naming / 22) x 20].

Table 4: Frequency of errors on the TWF calculated with adjusted scores (means and standard deviations in brackets)

GROUP (N = 20)	WORD TYPE: Errors on Nouns (total of 22 items)	WORD TYPE: Errors on Verbs (total of 20 items)	Mean errors
WFD sample	12.41 (2.89)	11.65 (3.01)	12.03
LA matches	9.86 (3.02)	8.90 (2.59)	9.38
CA matches	9.00 (3.74)	7.35 (2.68)	8.18
Mean errors	10.42	9.30	9.86

Levene's statistic for the test of homogeneity of variance is non significant for both Nouns (p = .2.94) and Verbs (p = .627), which reflects that the variances are equal.

Table 4 reveals that there was a high frequency of errors for nouns and verbs, and that children with WFDs made more errors than both the typical groups. Overall, children made more errors on nouns than on verbs. Inferential analyses were used to determine whether these differences were statistically significant. Tukey's post-hoc multiple comparisons test identified the significant differences.

Errors and Word Type. A two-factor mixed factorial ANOVA, with Group (WFD vs. LA vs. CA) as the between subjects factor (WFD, LA, CA) and Word Type (Noun vs. Verb) as the within subjects factor was conducted on the frequency of errors. This revealed a main effect of Word Type ([F (1, 57) = 11.837; p = .001]) and a main effect of group [F (2, 57) = 10.386; p = .001]. There was no interaction between Group and Word Type [F (2, 57) = .680; p = .511]. The children made significantly more errors on Nouns than on Verbs (p = .001) – with a large Eta effect size ($\eta p^2 = .172$). Children with WFDs made significantly more errors than both the LA (p = .010) and the CA typical control groups (p = .000). On the other hand, LA and CA matches did not differ significantly (p = .505). The Partial Eta Squared value indicated a large effect size ($\eta p^2 = .267$).

3.2. Error Profile across Groups

3.2.1. Frequency of Specific Error Types

To see whether there were differences in the frequency of different types of errors further analyses were conducted. Because of the relatively low frequencies, the data from nouns and verbs was combined and a non-parametric test was used.

Table 5: Frequency of different types of responses on specific types of errors on the TWF

Error types	WFD Mean (SD)	LA Mean (SD)	CA Mean (SD)	Test statistic χ^2 sig. (2-tailed)
SEMANTIC				
Taxonomic	4.25 (2.149)	5.35 (2.455)	3.95 (2.089)	$X^2(2) = 3.519$; $p = .172$
Thematic	3.80 (3.473)	4.10 (2.751)	3.00 (1.974)	$X^2(2) = 1.399$; $p = .497$
Novel compound	.55 (.686)	.55 (.826)	.60 (.883)	$X^2(2) = .056$; $p = .972$
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Mean number of errors	2.87	3.33	2.52	

PHONOLOGICAL	2.70 (2.179)	3.20 (2.167)	2.45 (1.638)	$X^2(2) = .884$; $p = .643$
UNRELATED				
Don't know	11.55 (6.832)	6.35 (6.368)	6.15 (4.682)	$X^2(2) = 7.674$; $p = .022$* [WFD > LA > CA]
Other	1.60 (1.930)	1.00 (.858)	.75 (.910)	$X^2(2) = 1.870$; $p = .393$
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Mean number of errors	6.58	3.68	3.45	

The first set of analyses concerned whether some types of errors were more frequent than others. A non-parametric Friedman related samples test was used. The analysis showed that for the 3 groups combined, there were differences in the frequency of different types of errors [$X^2(2) = 60.826$; $p < .001$]. A Wilcoxon test was used to specify the location of the significant differences. The output showed that there was a significant difference between the frequency of phonological and semantic errors [$N = 60$, $z = -6.726$, $p < .001$] and between the frequency of phonological and unrelated errors [$N = 60$, $z = -5.243$, $p < .001$]. There was however, no significant difference between the frequency of semantic and the unrelated types of errors [$N = 60$, $z = -.647$, $p = .518$].

It was also decided to conduct similar analyses on each of the three samples in order to determine whether different patterns could be observed for typical children and for the sample of children with WFDs:

(A) For children with WFDs, Friedman's test statistic showed that the pattern of errors differed significantly [$X^2(2) = 25.200$; $p < .001$]. As shown by Table 5, children with WFDs made significantly more unrelated types of errors whereas phonological errors were less frequent. Wilcoxon's related test indicated the presence of significant differences between all types of errors: semantic-phonology [N = 20, z = -3.927, $p < .001$]; unrelated-phonology [N = 20, z = -3.624, $p < .001$] and unrelated-semantic [N = 20. z = -2.073, p = .038].

(B) For the LA typical controls, Friedman related samples test showed the presence of a significant difference in the type of errors children made [$X^2(2) = 19.000$; $p < .001$]. A related samples Wilcoxon test revealed the presence of significant differences on the means between semantic and phonological errors [N = 20, z = -3.935, $p < .001$] as well as between the number of unrelated and phonological errors [N = 20, z = -2.056, p .040]. On the other hand, the number of errors was not significantly different between unrelated and semantic types of errors [N = 20, z = -.826, p .409].

(C) For the CA typical peers, Friedman's test revealed significant differences in the pattern of errors children made [$X^2(2) = 20.597$; $p < .001$]. Wilcoxon's related test showed that the number of semantic and phonological errors differed significantly [N = 20, z = -3.892, $p < .001$]. Likewise, there was a significant difference between the number of unrelated and phonological errors [N = 20, z = -3.186, p = .001]. However, there was no significant difference between the number of unrelated and the number of semantic errors [N = 20, z = -.566, p .571].

As children with WFDs produced more errors than the other groups, further analyses were conducted to try to identify which form of error was responsible for this difference. There was no significant differences between groups for any of the types of errors, except for the 'don't know responses', the children with WFDs produced significantly more of these types of responses compared to their typical matches (see Table 5 for test statistics).

In summary: The analyses showed that the most frequent errors were semantic or unrelated, and that children with WFDs produced more 'don't know' responses than the other children. For all children, phonological errors were the least frequent types of errors.

3.2.2. The Proportion of Errors: Comparisons across groups

The previous analyses concerned the frequency of errors, in this section the analyses concern whether there were differences between groups in the proportion of errors. Because the proportion of errors for a child will sum to 1, it was not possible to use a 2-way ANOVA with these proportions. Therefore, a one-way ANOVA was used to determine whether the proportion of errors was similar across groups. Tukey's post hoc multiple comparisons test was used to specify the significant differences. The output is summarised in Table 6.

Table 6: Summary: proportion of errors made and details of statistical analyses

Type of error	WFDs	LA	CA	(df)	F	Sig.
NOUNS and VERBS (TWF-Overall)						
Semantic	35.19 (18.07)	46.46 (18.31)	43.71 (18.18)	(2, 57)	2.479	.093
Phonological	12.46 (9.86)	16.38 (9.37)	16.73 (11.24)	(2, 57)	1.084	.345
Unrelated	52.35 (24.30)	37.16 (25.32)	39.57 (20.05)	(2, 57)	2.449	.095
OBJECT NAMING (TWF-N)						
Semantic	25.59 (18.16)	41.17 (18.18)	29.24 (14.76)	(2, 57)	4.535	.015*
Phonological	10.65 (14.33)	16.88 (13.94)	14.96 (12.72)	(2, 57)	1.086	.344
Unrelated	63.38 (27.31)	41.96 (29.20)	55.80 (21.25)	(2, 57)	3.452	.038*
ACTION NAMING (TWF-V)						
Semantic	45.29 (19.30)	52.17 (18.94)	58.05 (19.76)	(2, 57)	2.134	.128
Phonological	14.91 (10.73)	16.12 (11.38)	17.53 (14.57)	(2, 57)	.226	.798
Unrelated	39.80 (25.38)	31.71 (23.60)	24.42 (27.18)	(2, 57)	1.831	.170

An uneven distribution of errors was observed across groups. There was no significant difference in children's proportion of semantic, phonological or unrelated errors in relation to verbs. Significant differences were however observed in relation to nouns. Specifically, children with WFDs made significantly more *unrelated* types of responses [F (2, 57) = 3.452; p = .038] and significantly fewer *semantic* errors [F (2, 57) = 4.535; p = .015] than LA controls; although there were no significant differences with the CA group. Additionally, *phonological* errors were the least common types of errors for all children (see Table 6).

3.3. Lexical Factors in Relation to Word Finding Errors

The following section examines the relationship between the total number of errors children made on each of the 42 target items and the 5 lexical variables. Using similar procedures as German & Newman (2004), a new SPSS file was created containing a list of the 42 target words (i.e. 22 nouns and 20 verbs). For each of the target items, separate columns were created which contained information about each of the 5 lexical factors used in the current research. An additional column was created, which contained the frequency of errors for all the words (for nouns and verbs).

Table 7: Correlations between the number of errors and lexical characteristics (the probability value is given in brackets)

Number of errors	Frequency	Familiarity	Neighbourhood Density	Neighbourhood Frequency	Age of Acquisition
WFD	-.445**	.147	.272	-.232	-.257
	(.007)	(.601)	(.086)	(.217)	(.179)
LA	-.155	.300	.115	-.198	.086
	(.367)	(.277)	(.472)	(.293)	(.658)
CA	-.232	.088	.023	-.238	.128
	(.173)	(.755)	(.885)	(.205)	(.509)

**Correlation significant at the .01 level

As illustrated by Table 7, there was a significant negative correlation between the number of errors children with WFDs made and the frequency of the target word ($r = -.445$; $p < .01$). In other words, words with higher frequency tend to elicit fewer errors. A higher number of phonological neighbours (i.e. neighbourhood density) was also weakly ($r = .272$; $p = .086$) associated with a higher error rate. There were no significant correlations between lexical factors and the number of naming errors made by typical children. It should be noted that Bonferroni adjustments (with the number of tests equal to 20) identify the significance level as $p < .003$. As a result, one should exercise caution when interpreting the correlations.

IV. DISCUSSION

The three issues addressed in this study were the types of errors made by typical children and children with WFDs; whether children with WFDs made significantly more errors than typical peers and whether there was a relationship between lexical factors and the number of naming errors. These findings are discussed below.

Children's Naming Errors

The current study showed that children made significantly more errors on nouns than on verbs. It is claimed that verbs are not only learnt later than nouns (Tomasello & Brook, 1999; Gentner, 1981; Gleitman, 1994; Plunkett & Juola, 1999) but also more difficult to process due to their complex syntactic structure (Brackenbury & Fey, 2003; Gleitman & Gleitman, 1992; Nelson, 1973). The present findings do not support these claims. However, there are several studies that report superior performance with verbs rather than nouns. For example, Davidoff & Masterson (1996 with 3:0 to 5:5 children; see also Rice et al., 1994) present findings against what they call a *noun bias*. One should nevertheless exercise caution when interpreting these findings. Indeed, nouns and verbs from the TWF (German, 1989) have not been matched for frequency or level of difficulty.

Analysis of error patterns provides insight about the nature of the representations involved in the naming process and/or those representations that children have problems retrieving. The current research revealed an interesting pattern of naming errors for the typical and the WFD samples. The whole sample of children made more semantic and unrelated errors than phonological errors. For both groups of typical children the semantic and unrelated errors were significantly more frequent than phonological errors, however, the children with WFDs made significantly more unrelated errors than semantic errors, and significantly more semantic than phonological errors.

This is different from previous work (e.g. Dockrell et al., 2001; McGregor, 1997) which highlighted the predominance of semantic errors (for both typical and WFD children) and thus implicating the role of semantic representations to children's naming success. On the other hand, typical children indeed made more semantic errors. Overall, phonological types of errors were the least common. Again, this is dissimilar from McGregor's findings that unrelated errors were the least common. However, this difference is findings might be due to the age of the children investigated (3-5 for McGregor and 6-7 for the current study).

Higher frequencies of 'don't know 'responses in the current research lend support to earlier findings of Fried-Oken (1984; see also German, 1982) who reported higher rates of don't know responses in a sample of children with learning disabilities. It is possible that this response style might reflect metacognitive awareness of children with WFDs that they recognize a picture but fail to retrieve the correct name for the target. This also helps to explain why the children with WFDs used proportionately fewer semantic substitutions. Another possibility proposed by McGregor and colleagues (see McGregor & Windsor, 1996; McGregor & Waxman, 1998) is that a higher recourse to *unrelated* responses might be indicative of a difficulty in accessing semantic or conceptual information because the semantic representations are not well defined in these children's lexicon. However, one should be cautious when interpreting these findings as some researchers have also claimed that don't know responses might simply reflect children's unwillingness to answer (e.g. Fried-Oken, 1982; German, 1982).

In relation to *the proportion of naming errors*, the current data showed that there was no significant difference in the proportion of semantic, phonological and unrelated errors across groups when naming verbs. This finding corroborated what Dockrell et al. (2001) found in their sample of 6-7 year old children with WFDs when naming pictures of action targets. However, when naming objects, children with WFDs had a significantly lower proportion of semantic errors than their LA peers although the proportion was comparable to their CA peers. In addition, children with WFDs had a higher proportion of unrelated errors than their CA and LA peers. Data analysis revealed no significant difference in the proportion of phonological errors between the two groups of typically developing children. This pattern of findings broadly reflects the findings from the analysis of the frequency of errors.

Were there differences between groups in their errors?

A main effect of group was observed in relation to the frequency of errors. In other words, children with WFDs made significantly more errors than their chronological and language age matches, which is consistent with previous findings (McGregor, 1997; Dockrell et al., 2001; 2003), thereby confirming that the naming abilities of children with WFDs are below what one would normally expect based on chronological age and language ability. This effect seems to be due to the children with WFDs producing more 'don't know' responses. In addition, children with WFDs were found to produce a higher proportion of 'don't know' responses than the other groups of children, and a lower proportion of semantic errors than the language age control group. The implication for research on word finding deficits is that the naming difficulties that the WFD sample experience are greater than one would expect on the basis of their receptive vocabulary. As stated by Dockrell et al. (2001), the presence of significant differences between children with WFDs and LA matches might indicate a different pattern of development for the WFD sample, although further research would be needed to confirm this.

Were lexical factors related to the number of errors children make when naming pictures?

The current findings showed the presence of a significant correlation between word frequency and the number of errors made by the WFD sample. Thus, lower frequency words tend to have a higher error rate when naming. There was also a trend for neighbourhood density (i.e. the number of phonological neighbours a word has) to be related to the number of errors children with WFDs made. This corroborates the hypothesis put forward by Vitevitch & Sommers, 2003 that 'dense neighbourhoods' are associated with a higher number of errors. It is also worth noting that the correlations observed in the current study were similar in size to those obtained by German & Newman (2004) when examining these relations in 8 to 12 year old children with WFDs. Indeed, German identified word frequency ($r = -.29$; $p = .006$) and neighbourhood frequency ($r = -.34$; $p = .001$) as significant predictors of naming accuracy. The current research however failed to identify significant correlations between lexical factors in the groups of typical children. It is unclear why this was the case although the lack of significance might be attributed to the small number of target items used (42 pictures in the current research whereas German used 106 pictures).

Another reason, as suggested by Arnold et al. (2005; see also Newman & German, 2002) might be that the influence of lexical factors changes across development. Nevertheless, the size of the correlations detected in both studies (i.e. German and the current research) suggests that no one lexical characteristic is an important determiner of the error rate for words, but collectively lexical factors contribute to the prediction of error rates. However, further research is needed to ascertain the importance of lexical factors to the speed and accuracy of children's naming.

CONCLUSION

The current research showed that the most frequent naming errors were semantic and unrelated. Children with WFDs were significantly less accurate when naming actions and objects than typical children matched on age and comprehension abilities. The children also showed a different pattern of errors as they produced more "*don't know*" responses than the typical children. A related pattern also occurred for the proportion of errors. Finally, analysis of lexical factors revealed that only word frequency and neighbourhood density were associated with a higher error rate and this only occurred in the WFD sample. The lack of widespread significant correlations between lexical characteristics and the rate of naming errors suggests that this is not the most important factor in determining the success of word retrieval but instead, variables such as participant characteristics are more important.

CHAPTER VI

LEXICAL ACQUISITION IN TYPICAL CHILDREN

I. Introduction

The capacity to learn novel words is a remarkable human ability, and can impact on children's academic success (Baumann, Kameenui & Ash, 2003; Kurdek & Sinclair, 2001) or on children's more general language and communicative abilities (Akhtar & Tomasello, 2000). Building a lexicon consists in establishing a relationship between a word, the event or object it represents (i.e. the referent) and related concepts in the lexicon (Waxman & Lidz, 2006; Ogden & Richards, 1923). This ability to map word meanings onto word forms enables children to become proficient word learners. Early vocabulary acquisition has been the subject of numerous investigations. Nevertheless, there remains uncertainty about how novel words are integrated into the listener's mental lexicon and the way this happens in the primary school years.

Infants and young children soon become proficient in acquiring the vocabulary of their native language (Bloom, 1998; 2001b). Especially intriguing is their ability to learn new words within a relatively narrow time span and despite possessing limited information processing abilities (e.g. in terms of hypothesis testing, reasoning, attentional resources and so on). The ability to learn novel words undergoes rapid development throughout childhood and as summarised by Fisher & Gleitman (2002), "*language learning is rapid, accurate and efficient*" (p.445).

The important milestones achieved in relation to typical development are well documented. Newborns can already discriminate between the acoustic properties of different words that they hear (Aslin et al. 1998; Jusczyk 1997). At around 8-12 months, infants produce their first word. According to Bates and colleagues (Bates, O'Connell & Shore, 1987; Bates, Bretherton & Synder, 1988), vocabulary increases suddenly, soon after the child has acquired roughly 30 to 50 items. The rapid expansion of vocabulary has been attributed to a *naming insight* (McShane, 1979) where children realise that all objects have names and words can be used to refer to these objects (Dore, 1978; McShane, 1980; Gershkoff-Stowe, 2002; Nazzi & Bertoncini, 2003). It is believed that this vocabulary expansion occurs in the 18-24 month age range, although there is uncertainty about the exact time of the increase (Gershkoff-Stowe & Smith, 1997; Hollich, Hirsh-Pasek, K & Golinkoff, 2000). However, there have been indications that, at least for some children, vocabulary growth around this period is more gradual. For instance, Ganger & Brent (2004) examined parental reports of 15 month olds concerning the words children used. Findings showed that only 1 child out of 5 showed this sudden vocabulary growth.

By 2 years of age children possess a vocabulary of roughly 300 words (Dapretto & Bjork, 2000; Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994) and by 6 years of age, most children have acquired a vocabulary of 10,000 to 14,000 words and are learning up to 9-10 novel words per day (Anglin, 1993; Miller, 1991). According to Bloom (2001a & b), 6 year olds possess a sixth of the words that will be known by the end of formal education. Vocabulary growth increases steadily until adulthood where approximately 60,000 words are known by 18 years (Aitchinson, 1994; Bloom, 2002).

The study of how children acquire novel items to expand their vocabulary, and subsequently become proficient word learners, is the subject of ongoing interest. In this chapter, there will be a discussion of the processes of early word learning (i.e. during the preschool years). This will be followed by a section about learning in older children (i.e. school years). The next section draws attention to the links between word learning and word production. The two final sections introduce the design, rationale and assessments used to 'measure' word knowledge.

II. Models and Theories of Word Learning

It is unclear how children solve the puzzle that is word learning (Waxman & Lidz, 2006) and how they achieve a level of proficiency so quickly. The acquisition of novel word meanings has been explained in a number of different ways. Some of the main proposals, first in relation to the preschools years then in relation to later acquisition, are reviewed below.

2.1. Early Word Learning Acquisition

Lexical constraints approach: Theorists of the constraints approach consider word learning as an inductive problem (Medin, Ahn, Bettger, Florian, & Goldstone, 1990) where children need to solve the puzzle that is word learning – or the *indeterminacy of reference* (see Quine, 1960). To do so, it is believed that children rely on a range of built-in constraints (or defaults assumptions) to determine possible word meanings. These lexical biases (see Clark, 1997) are believed to restrict the number of possible choices (Markman, 1989) so that some meanings will be preferred above others (Medin et al., 1990). According to these theorists, these lexical principles are present from birth (*hardwired* in the brain – see Imai & Gentner, 1997) and are applied in a mechanistic (or automatic) manner. A number of cognitive constraints have been identified that involve children approaching "*word learning with a bias to make certain assumptions over others in determining what a word might mean*" (Hirsh-

Pasek, Golinkoff & Hollich, 2000; p.138). For example, the *whole object constraint* (Markman & Hutchinson, 1984) explains how children extend a label (e.g. dog) to a whole object (i.e. the whole animal), rather than to its parts (e.g. ear) or properties (e.g. colour). The *taxonomic constraint* (Markman, 1990) explains how children extend novel word meanings to objects of a similar kind (e.g. all four-legged animals are labelled as "*dog*" – including cats or sheep). The *principle of contrast* (Clark, 1983) explains how each novel word contrasts with pre-existing words in the lexicon.

There is controversy regarding the constraints approach (Clark, 2003; Nelson, 1988). The mechanism underlying the emergence of constrains is unclear (Nelson, 1990); there are uncertainties as to whether these constraints apply to words that are not nouns; and there is also evidence that children can override these assumptions. As a challenge to the constraints approach, Markman & Wachtel (1988) found that 3-4 year olds were able to override the whole object assumption provided children were familiar with the whole object. Thus, a child who is familiar with "*fish*" (the whole) could learn the novel word "*dorsal fin*" (the part) and point to it. Kobayashi (1991; 1998) found that children could override the whole object assumption with unfamiliar objects as well. For example, 2 year olds could choose the part "*nut*" (rather than the whole, a "*u-shaped bolt*"), when the experimenter named and/or focused on the part. These examples illustrate Golinkoff, Mervis & Hirsh-Pasek's (1994) argument that cognitive constraints only apply in certain *optimal conditions* that are not representative of all real-world learning contexts. And to date, there is growing evidence that the constraints approach does not provide an adequate conceptualisation of word learning as it fails to capture the flexibility and diversity of word learning (Bloom, 1997; Deak, 2000 for a review of the limitations of the constraints approach).

CHAPTER VI: Literature Review Pt. 2

The *socio-pragmatic approach of word learning* addresses one of the limitations of the constraints' approach concerning the social dimension of word learning. Theorists of this approach claim that children learn new words actively, rather than by the passive, associative processes posited by the constraints' proposal. An important body of work in this tradition has its roots in Vygostky's (1978) theory that learning takes place through interaction with more capable peers. Similarly, the socio-pragmatic approach focuses on the fact that children are part of a social nexus (Aktar & Tomasello, 1998; 2000) and, guided by expert word learners, are able to infer word meanings by drawing on social cues (Tomasello & Akhtar, 1995) from as early as 9-10 months old (see Woodward, 1999). Through their studies, Baldwin and colleagues found that 12 to 18 month old infants *actively*, and spontaneously, used social cues present in the environment (such as the speakers emotional expression or body posture and so on) in order to guide their interpretation of language (see Baldwin, 2000; Clark & Wong, 2002). Such instances of interaction can consist of routinized activities such as joint attention (Tomasello & Farrar, 1986; Baldwin, 2000), gaze direction (Baldwin, 1993a; Corkum & Moore, 1995) or use of gestures (Behne, Carpenter & Tomasello, 2005; Carpenter, Nagell & Tomasello, 1998) which act as cues to adults' (or speakers') referential intentions. Examples regarding each of these types of activities are provided below.

To illustrate how children are attuned to the social cues adults provide, Tomasello & Farrar (1986) examined instances of *joint attention* between the mother-child dyad. These authors observed interactions (typically through play session with novel toys) between 15 months old infants and their mothers. Positive correlations were found between instances of joint attention and children's vocabulary at 21 months.

There is also evidence that *gaze direction* assists word learning. The work of Baldwin (Baldwin, 1991; 1993; 2000; Baldwin et al., 1996) has shown how young children read the intention of the speaker to derive novel word meanings. For example, Baldwin (1993) found that 16 month old infants were only able to infer adults' referential interest from the direction of eye gaze. This has been examined further with 18 month olds (Baldwin, Markman, Bill, Desjardins, Irwin & Tidball, 1996). In this study, if the adult gazed at an object, children were able to learn the novel word. However, if the adult pretended to be on the telephone and excitedly uttered the same label, learning did not take place – even though the referent was in close proximity.

In relation to gestures, Baldwin & Markman (1989) found that by 17 months of age, young children were able to make the connection between pointing to an object and labelling of the object (also see Capone & McGregor, 2005 with 27-30 month olds). Children who saw gestures were better at comprehension and production of relevant words than the control group.

As illustrated above, theorists of the socio-cognitive approach have focused on situations based around the object-naming game (Tomasello, 1998) where adults/parents typically pointed to and named objects. One of the limitations of this approach is that this proposal does not take into consideration other types of situation swhere words are acquired indirectly or in *non-ostensive* contexts.

The *emergent coalition model of word learning* (Hollich et al., 2000) builds on the importance of both social cues and lexical principles. According to this model, young word learners are biased to attend to, and integrate, multiple cues such as attentional processes, linguistic heuristics (i.e. cognitive constraints) and social cues (i.e. from 'expert' word learners) to resolve new word meanings. Thus, children do not use these constraints in a rigid and automatic manner, but these operate more in a problem-solving approach.

Unlike the constraints approach, in the emergent coalition model it is assumed that lexical principles are not present from the beginning (there are also suggestions that these might differ across cultures; see Hollich et al., 2000) but instead, these principles of word learning are emergent. In addition, the cues that children use are differentially weighed over the course of development and this is mainly attributed to children's experience with words and/or interaction with adults. Observation of 12-25 month olds led researchers to speculate that the change in the relative "weighting" of these cues could explain the developmental change in vocabulary growth in the second year of life (Golinkoff et al., 2000). Younger children are believed to rely predominantly on perceptual (salient) cues; whereas older children rely more on social cues (such as eye gaze, intentionality in gestures and so on). According to this model, word learning principles are flexible and evolve over the course of development.

Fast mapping of words from minimal exposure

The theories and models discussed so far have focused on the sources of information that are used in early word acquisition. There also have been investigations into how quickly pre-school children can map novel objects to novel meanings on the basis of one or two exposures. The ability to create new lexical entries on the basis of minimal exposure has been conceptualised as *fast mapping* (Carey, 1978; Heibeck & Markman, 1987), and occurs when a child rapidly encodes an unfamiliar word after a few experiences with it (Dollaghan, 1985; Rice & Woodsmall, 1988). The concept of fast mapping was described in Carey & Bartlett's (1978) classic experiment with typical 3-4 year olds. Children were able to map an unfamiliar colour (olive) to a novel label (chromium) and correctly infer the novel word meaning – i.e. the "*chromium tray*". Several researchers took Carey's research further.

For example, Dollaghan (1985) found that 81% of her sample of 2-5 year olds was able to express comprehension of a novel word ("*koob*"), after only one exposure. Similarly, Senechal (1997) examined 3 and 4 year olds' performance when listening to stories containing novel words. There was evidence of minimal learning with a single presentation. This led researchers to speculate that a first exposure to a novel word brought children to a level of 'lexical comprehension' (Keenan & MacWhinney, 1987). This is consistent with Carey's (1987) suggestion that lexical acquisition proceeds in two phases. A first phase enables the creation of a "*roughed up*" representation, where partial knowledge of the new word form is available. In a second, more extended phase (*slow mapping*), phonological and semantic representations are refined (and strengthened) in memory over time. This consolidation of information generally occurs after additional encounters with the word. Instances of fast-mapping have been observed in typical development as early as 13 months (Schafer & Plunkett, 1998).

2.2. Word Learning Acquisition in the School Years – Beyond Fast-Mapping

As illustrated above, there has been substantial interest in early word-learning. And fast mapping techniques typically refer to the initial learning that takes place after a first exposure to a novel word (such as Carey's classic experiment). Fast mapping studies have also mainly focused on preschool word learners. However, it is also important to consider this process in older children. Indeed, school children learn thousands of words each year (Anglin, 1993; Baumann & Kameenui, 1991) and more needs to be known about the processes underpinning this remarkable achievement. Additional studies have extended the period of learning beyond the initial fast mapping using quick incidental learning contexts (e.g. Alt, Plante & Creusere, 2004), which will be discussed further in this section.

Researchers have identified two main sources of vocabulary learning in which school children can learn new words. There has been an interest in explicit word teaching of new words and this is described using terms such as intentional word learning, or direct (or explicit) learning; there has also been interest in word learning in other contexts and this has been described as incidental (or quick incidental – see Rice and colleagues) or indirect word learning (Nagy, Herman & Anderson, 1985; Penno, Wilkinson & Moore, 2002; Senechal, Thomas & Monker, 1995). These will be discussed further in the following sections.

In this section it is argued that although many investigations have considered word learning in intentional contexts, there are good reasons to focus on word learning in incidental contexts. Researchers have found that explicit vocabulary lessons in classroom teaching were unlikely to account for all children's vocabulary growth (Beck, Perfetti & McKeown, 1982; Nagy & Herman, 1987; Nagy, Anderson & Herman, 1987). Other researchers have compared vocabulary gains under both these learning conditions (Jaswal and Markman, 2003; Nagy & Herman, 1987; Senechal, LeFevre, Hudson & Lawson, 1996) and these studies will be described later on.

Intentional (or direct) learning contexts have been described as situations where the explicit purpose of an interaction is to teach the meaning of a word. Such instances of direct instruction typically occur in school settings (Nagy et al., 1985; Penno et al., 2002). Indeed, it is relatively well-established that teacher explanation can help children understand novel word meanings and may also lead to vocabulary growth (see Beck et al., 1982; McKeown, Beck, Omanson & Pople, 1985; White, Graves, & Slater, 1990). However, several researchers have found that direct or explicit explanations about new words were not always provided in class. Durkin (1979) carried out a classroom survey from Grades 3 to 6 and found that a relatively small percentage of time was spent in explaining novel words (Beck et al., 1982). The fact that teachers seldom offered formal vocabulary instruction has also been reported by Carlisle, Fleming & Gudbrandsen (2000) and more recently, Best et al. (2006b).

In contrast, incidental learning contexts provide indirect (or implicit) contextual information, where children are required to infer word meanings. As Carey & Bartlett (1978) summarised, such learning contexts are defined as "*a situation in which there was no direct teaching*" (p.13). Incidental learning contexts include oral situations where children overhear words in conversation (Akhtar, Jipson & Callanan, 2001; Forrester, 1993); though reading or listening to stories (Brett, Rothlein & Hurley, 1996; Elley, 1989; Nagy et al., 1987; Senechal et al., 1995); or via television or quick incidental learning tasks (Rice & Woodsmall, 1988; Rice et al., 2000).

There is agreement that when words are encountered in situations where they are not formally taught (i.e. incidental contexts) this can lead to robust mappings (Jaswal & Markman, 2003) and that these circumstances are likely to be responsible for the bulk of vocabulary growth (Senechal et al., 1995). For example, Penno et al. (2002) examined the performance of 5 to 8 year olds, where children listened to 10 novel target words embedded in a story. Word knowledge was assessed by a multiple-choice test and a story retell. In one condition, the experimenter explained the meaning of the unfamiliar words by either pointing to a picture (e.g. "*see*, [...] *is* [...] *sitting under the* verandah") or by providing a definition (e.g. a *hornet is like a wasp and buzzes around and might sting you*). A second condition presented the words, orally but without explanation. Findings indicated that, in both conditions, children acquired knowledge of those words. Likewise, Senechal et al. (1995) examined 5 year olds' incidental learning from stories. Thirteen target words were used e.g. *angling*, *fedora*, *slumber* etc. Two experimental conditions were set up. In a *listening* condition, children 'passively' heard a story with novel words. In a *labelling* condition, children heard a story but they were asked *what* or *where* questions after sentences containing the target words (e.g. "*What is Arthur doing?*" for target word: *angling*). Despite observing significantly higher vocabulary gains in the second condition, there was also evidence that children 'learnt' just by hearing the words in a story context.

As mentioned earlier on, some researchers have compared the vocabulary gains in both types of learning situations. Jaswal & Markman (2003), investigating the word learning performance of three years olds, found that both types of learning led to robust, mappings – as assessed by scores on comprehension tested immediately after learning. In one of the earlier reviews of word learning, Nagy & Herman (1987) compared the relative importance of incidental vocabulary learning compared to intentional vocabulary instruction. The authors emphasised the importance of incidental learning situations as a means of explaining the significant expansion of vocabulary observed throughout childhood (see also Senechal et al., 1995). Because teachers provide very little explicit vocabulary instruction at school (see Carlisle et al., 2000; Best et al. 2006b; Nagy & Herman, 1987), children must necessarily learn these new words from other (incidental) sources. As summarised by Nagy & Herman (1987; p.23): *"[...] explicit vocabulary instruction, even at its best, cannot produce substantial gains in overall vocabulary size [...] Major progress toward these goals can be attained only by increasing incidental vocabulary learning*" (p.19). Similar conclusions were formed by Senechal and colleagues, in that direct teaching cannot account for such rapid growth in young children's word learning (Senechal et al., 1996; Senechal, 1997): "*Direct instruction accounts for some vocabulary acquisition [...] but a substantial number of lexical items must be acquired incidentally to account for the large gains [...]*" (p.218).

Incidental learning contexts are thus an important component of vocabulary development. For this reason, the focus of the current investigation of children's word learning processes (see the next two chapters) was on incidental learning situations. Moreover, as mentioned earlier on, an important form of incidental learning is shown by the Quick Incidental Learning (QUIL) paradigm. As summarised by Brackenbury & Fey (2003), Rice's QUIL could be defined as "*an elaborated model of fast mapping that was designed to reflect young children's everyday experiences with new words*" (p.314). The QUIL format has been one of the most important methodologies to study incidental learning. And thus, it was decided to adopt a paradigm that was similar to the one used by Rice and colleagues, to investigate typical school age children's word learning.

Rice and other researchers have produced an important body of work (see Table 1 for summary of main studies investigating incidental learning) looking at the importance of stories presented via a video- or in a computer-story context. This stemmed from observations that television, without any clear intent to 'teach', could nevertheless promote language acquisition (Lemish & Rice, 1986; Rice, 1983). A clear advantage of the QUIL paradigm is that it simulates 'real word' (or naturalistic) learning situations but also is an ideal vehicle to manipulate the presentation of the information that one wants children to receive. In addition, it is particularly useful for investigating word learning in older children (i.e. primary school age range).

One set of studies that have looked at children's word learning in incidental story contexts via television or video context is provided below. For example, Rice, Cleave & Oetting (2000) compared the performance of children with SLI in relation to typical peers. Videotaped stories with voice-over narrative were used to introduce the novel words (varying along 4 semantic classes – i.e. object, attribute, action and affective state). Word learning was subsequently assessed by a picture-pointing task. Findings indicated better comprehension gains for the typical children. In another study, Rice et al. (1994) examined 5 year old children with SLI and typical peers. The authors manipulated the frequency of presentation of words (0, 3, and 10 exposures) and the type of word used (noun and verb). Findings showed an effect of frequency that was influenced by the type of sample and word type.

Table 1: Summary of main findings from studies investigating children's word learning in incidental story contexts

Studies	Population & Age	Stimuli & Procedure	Assessments of Word Learning	Outcome
Lemish & Rice (1986)	Observation 1: 6 mths to 2:5 Observation 2: 1:2 to 3:0 ND	When viewing TV at home Observations for period of 6-8 months Transcript of children's verbal behaviour: designation, questions, responses and descriptions.	Observation and analysis of transcripts	TV serves as a facilitator of children's language acquisition
Carey & Bartlett (1978)	3 & 4 year olds	Two trays of different colour: blue and olive 1 exposure Children asked to "*bring the chromium tray, not the blue one*"	Comprehension	Evidence of learning for all children
Ellis-Weismer (1997)	Kindergarten 8 SLI 8 ND*	Game activity: Sam the outer space man introducing 'alien' words Manipulation of emphatic stress	Naming the toy Demonstrate comprehension: "*Put Sam by the tob*".	Evidence of learning No effect of stress ND > SLI prod ND=SLI comp
Markson & Bloom (1997)	Replication of Carey & Bartlett study 3 & 4 years olds and adults	Exposure to 10 objects. Participants were required to use some objects to measure other objects. "*Let's use the koba*", "*Let's put the koba away now*"	Comprehension: tray with the 10 objects "*Can you show me the koba?*"	Evidence of fast mapping, even after 1 month
Dollaghan (1985)	N = 5 2:1 to 5:11 ND*	Novel word: 'koob' matched with novel object monosyllabic nonsense words Word introduced during a hiding game	Comprehension and production tasks: "*What is this?*"	After 1 exposure: evidence of comprehension After 2 exposures: production

Booth & Waxman (2002)	N = 24 3 year olds ND*	Novel nonsense words (e.g. 'dax') 10 min story about target 6 repetitions	Comprehension task: choose target among distractors *"Show me X?"*	Evidence of learning
Sabbagh & Baldwin (2001)	N = 48 3-4 year olds ND*	Taught 2 novel words: 'blicket' & 'dawnoo' Game: where experimenter either knows about unfamiliar toys (or not) 8 repetitions	Comprehension *"Put X in the box"* Production: *"What is this?"*	Learning occurs only when experimenter knowledgeable 3 year olds < 4 year olds
Rice & Woodsmall (1988)	N = 61 3-5 year olds ND*	20 real, low freq, words from 4 categories: object, action, attribute, affective state On average 5 exposures of each words; 7 exposures for 'artisan' and 14 exposures for 'viola' QUIL: 15 min TV program with voice over narration	Comprehension choose 1 of 4 pictures	Evidence of learning Effect of age: 3 year olds < 5 year olds
Brackenbury & Fey (2003)	4-6 year olds ND	5 target words (frolic, saunter, scurry, strut and trudge) presented within an ongoing narrative 13 repetitions for each word	Comprehension testing: immediately after each word's vignette was presented	Correct identification as evidence of learning (or mapping)
Dollaghan (1987)	N = 11 ND 4:0 to 5:6 N = 11 LI 4:1 to 5:4	FM: nonsense word presented with referent: 'koob' Presented as a game: 1 exposure of word	Comprehension and production tasks: *"What is this?"*	Evidence of fast mapping LI < ND Performance comprehens. > production
Rice, Buhr & Oetting (1992)	20 SLI 32 CA 20 LA 5 year olds	5 Novel object & attribute QUIL: 2 stories 2 conditions: introduction of pause before novel word vs. no pause	Comprehension test	No effect of pause LI < CA

Rice, Oetting, Marquis, Bode & Pae (1994)	N = 30 5 year olds LI and 2 ND (CA and LA)	Real words: (nouns vs. verbs) QUIL paradigm: Freq of input : x1, x3 and x10	Comprehension: immediate & after delay (several days) *"Show me X?"*	Evidence of learning Frequency & word type effects LI < ND*
Rice, Buhr & Nemeth (1990c)	20 LI 20 LA 34 CA 2-6 year olds	4 kinds of words (object, action, attribute and affective) QUIL: Video presentation with novel words embedded in story	Comprehension: choosing one picture out of 4	Evidence of learning LI < LA < CA
Storkel (2001 – nouns; 2003 – verbs)	N = 34 3:2 to 6:3 ND*	8 nonwords: 4 common sound sequence & 4 rare sound sequence Story presentation – 3 conditions: x1, x4, x7, 1 week delay Effect of phonotactic probability (i.e. the likelihood of occurrence of a sound sequence)	Form testing, referent testing, picture naming	Common sound sequences learnt more rapidly than rare sound seq.
Huston, Wright & Rice (1990a)	Two year longitudinal study: 3 to 5 years & 5 to 7 years	Different types of programmes watched: Observation of gender differences or influence of types of programmes	Viewing Television programmes	Children watched more cognitively demanding programmes with age
Rice, Huston & Truglio (1990b)	Grade 1: 3 to 5 Grade 2: 5 to 7 ND	Observations of vocabulary development of children watching TV programme	Children watching "Sesame Street"	Positive effect of TV tutorial from 3 to 5 <u>but</u> declining effects from 5 to 7
Ellis-Weismer & Hesketh (1993)	N = 8 5:4 to 6:7 SLI N = 8 5:1 to 6:2 ND	Effect of prosodic & gestural cues on lexical learning Manipulation of: rate, stress, gestures (V cdtion)	*"What is X?"*	Effect of rate and gesture No effect of stress

Rice, Cleave & Oetting (2000)	Study 1: 5 year olds SLI vs. ND (CA/LA) Study 2: 7 year olds: SLI and ND*	Videotaped story w/ novel words: syntactic cues vs. no syntactic cues		Both able to use syntactic cues
Horohov & Oetting (2004)	N = 54 5-7 year olds 18 SLI 36 ND* (CA & LA)	Novel words embedded in narrative Videotaped reading of stories Manipulation of 3 variables: presentation rate, sentence complexity, word type (Noun vs. verb).	Picture pointing task Real word synonym task	SLI children have lower scores in fast rate presentation. Main effect of word type (higher scores on V than N)
Ellis-Weismer & Hesketh (1996)	N = 32 SLI & ND matched on mental age Mean age: 7:2	Introduction of novel words Speaking rate variation	Comprehension "*What is X*?"	Evidence of learning No effect of rate
Oetting, Rice & Swank (1995)	N = 88 28 SLI 60 ND* 6 to 8 year olds	20 real words (object, attribute, action, affective) QUIL paradigm: two 6 min stories Manipulation of exposures: x5, x7 and x14	Comprehension (picture pointing): "*Show me X?*"	Evidence of learning SLI < ND* SLI: low gains on Verbs
Ellis-Weismer (1997)	Follow up study with 8 year olds 20 SLI 20 ND*	Game activity: Sam the outers-pace man introducing 'alien' words Manipulation of stress	Naming the toy Demonstrate comprehension: "*Put Sam by the tob*".	Evidence of learning Sig. effect of stress for prod. ND > SLI
Ellis-Weismer & Hesketh (1998)	20 SLI 6:8 to 9:8 20 ND 6:3 to 9:8	Novel word presented in a game format Manipulation of emphatic stress	Comprehension test: "*What is X?*"	Evidence of learning No effect of stress

Horohov (2000)	N = 54 SLI vs. ND (CA and LA) * age not specified	Manipulation of: Speech rate, sentence complexity and word type	Comprehension	Main effect of word type, group and rate.
Rott (1997)	ND *age not specified	Incidental learning of novel words in another language 6 unfamiliar target words introduced Manipulation of exposure: 0, 2, 4 & 6 presentations	Definition and MCT	Significant increase after 2 exposures No significant difference between 2 and 4 exposures Receptive & productive gains

ND*: Normally Developing children of similar chronological age

Although QUIL and related studies have provided a range of information about word learning studies there are some limitations to this body of research. As can be seen in Table 1, the majority of the QUIL studies have focused on the preschool age range and mostly consist in comparing the performance of language-impaired children with typical peers. Another limitation is that few studies have assessed word production but have instead mostly focused on word comprehension. There are some limitations to this approach as comprehension tasks are believed to merely reflect partial knowledge or can be the product of guessing (Anglin, 1993; Miller, 1999; Ralli, 1999).

It was thus decided to extend the existing knowledge-base by looking at children beyond the age of 5-6. In previous QUIL studies, children were typically shown only a limited number of target words and in most instances, the assessment(s) of word learning immediately followed the presentation of each target word. Finally, QUIL studies have rarely manipulated the provision of semantic or visual input. In order to extend the field of research, it was decided to address these issues so as to gain more insight into typical word learning and, by proposing a wider range of tasks than used by previous work, investigate how complete children's initial representations of newly acquired words are.

2.3. Cognitive Processes in Word Learning: Links between Word Learning and Word Production

As has already been discussed in previous chapters, knowledge involving representations at the lemma and lexeme levels is necessary for word production (e.g. see Levelt, 1989; Levelt et al., 1999) and consequently, both types of representations need to be acquired during the word learning process. According to several researchers, children extract word meanings from oral contexts through a series of overlapping steps (Fisher & Gleitman, 2002; Gershkoff-Stowe & Hahn, 2006). Senechal (1993) broke the process down in a five-step analysis, though these steps are not clearly delineated but instead, overlap with one another. First, there is a need to encode the phonological representation of the unfamiliar word that children hear. Indeed, upon first hearing a new word, children need to analyse its specific sound structure and subsequently encode and store a corresponding phonological representation of the word. It is believed that in a first instance, this phonological form is often weak and/or incomplete (Carey, 1978; Carey & Bartlett, 1978). The creation of stable, and reasonably detailed, phonological lexical entries is believed to be critical to learning novel word forms (Demke, Graham & Siakaluk, 2002; Dockrell & Messer, 2004; Dollaghan, 1994).

The next two steps are supposed to be inter-related. These consist in extracting additional information (such as syntactic cues, semantic cues and/or pictorial cues) from the context in order to aid the inferential process when constructing an appropriate meaning. This inferred meaning will subsequently be associated with the phonological specification of the word (Fisher & Gleitman, 2002; Gleitman, Cassidy, Nappa, Papafragou & Trueswell, 2005). Indeed, when learning new words, it is commonly agreed that children must attend to the semantic (Gray, 2005) information available. The process of lexical acquisition is thus reliant on *conceptual* abilities and involves the creation of links between a novel word and the semantic domain (Anglin, 1993; Booth, Waxman & Huang, 2005). Gleitman et al. (2005) have indicated that one of the reasons that some children failed to acquire some words is not because they do not know the phonological form of the word but these children have difficulties in mapping meanings onto their corresponding lexical form (see also Deak & Wagner, 2003; Gray, 2005; Waxman & Lidz, 2006)

A final aspect of word learning consists in integrating the new knowledge with the pre-existing knowledge base (Nagy & Herman, 1987; Senechal, 1993; 1995) or in linking it to their existing schemas (see Bromley, 2007) so as to enable a restructuring of children's existing knowledge (Clark, 2002; Tomasello, 2002). As vocabulary expands and new concepts are learnt, the process of word acquisition is believed to become less dependent on learning the phonological form of unfamiliar words, but more so on children's ability to associate the novel items with pre-existing information (Deak & Wagner, 2003). As Beck et al. summarised (1982; p.507): "*A related aspect of knowing a word well is [...] the quality of connections among concepts in semantic memory*". Preschoolers' behaviour is thus said to be consistent with *smart* mechanisms of word learning because the ability to form new concepts becomes so efficient (Booth & Waxman, 2002; Booth, Waxman & Ting Huang, 2005).

Thus, a range of different forms of knowledge need to be acquired during the word learning process. This highlights the importance of using a range of assessments to better understand the forms of knowledge that children acquire during word learning. The next section outlines the methods that can be used to assess this knowledge. It was decided to include a range of measures involving both children's receptive and expressive abilities. As several researchers reported, comprehension and production are believed to involve processes that require different cognitive demands (Barsalou, 1999; Donaldson & Laing, 1993; Nash & Snowling, 2006). In addition, in order to take further Funnell, Hughes & Woodcock's (2004) distinction between *naming* and *knowing* abilities, it was decided to assess children on a picture naming task and on a range of other abilities investigating what children know about a new word (e.g. semantic properties, or phonological specification of the novel words, see also Barrow, Holbert & Rastatter, 2000).

Assessments of lexical knowledge

Previous assessments of lexical acquisition have mainly used multiple choice comprehension tasks (MCTs) where children select a target from a set of distracters. In many respects, for the word learner, this is one of the least difficult assessments of learning as the phonological form of the word is provided together with a visual exemplar that is related to the semantic and conceptual information about that word. The child's task is simply to make the correct connection between these two forms of lexical knowledge (Booth & Waxman, 2002). Several researchers have criticised the use of such flat measures of vocabulary, because they fail to "*explicitly address the form of the memory trace that has been created and whether this information has been stored in long-term memory*" (Gaskell & Dumay, 2003; p.106).

To illustrate the limitations of multiple-choice tasks, Ralli (1999) examined the performance of 4 to 6 year olds when learning novel words embedded in a story context. The author varied the type of exposure by using definitions (e.g. "*The Y is a type of fruit*"), lexical contrasts ("*Look at the X not the Y*") or analogies ("*X is like a Y*"). Lexical knowledge was assessed via MCT, naming, definition and so on. Several findings emerged. First, the type of exposure appeared to influence children's performance on particular tasks and this, in turn, affected the types of lexical representations children formed. Secondly, higher scores were obtained on comprehension. The author proposed a conceptualisation of the process of lexical acquisition in the form of a pyramid – where the acquisition of lexical knowledge was graded from easy to more difficult. The 'easiest' knowledge as reflected by the MCTs was at the bottom of the pyramid. Other forms of word knowledge, as assessed by production or definition tasks were placed at a 'higher level' in the pyramidal structure as they were believed to represent more complex (or *deeper*) word knowledge.

Not surprisingly, there also are concerns that MCTs provide a limited assessment of the nature of lexical knowledge – where information about the depth, type and nature of word learning are largely absent (Kameenui, Dixon & Carnine, 1987; Ralli &

Dockrell, 2005). A number of authors have suggested that MCTs can reflect partial knowledge (Miller, 1999; Ralli, 1999) or are the product of guessing (Anglin, 1993).

Although the information provided by MCTs gives an overall assessment of word learning, it is becoming increasingly clear that vocabulary knowledge is a multi-faceted phenomenon (Nash & Snowling, 2006) involving both receptive abilities (i.e. comprehension of the novel item) and expressive abilities (ability to spontaneously produce the phonological form of the unfamiliar item). As a result, there is a need to adopt a more comprehensive approach, by using tasks believed to tap into different types of lexical abilities, so as to ascertain what a child learnt about a word (Beck & McKeown, 1991; Huttenlocher, 1974; Miller, 1999) or the extent of their knowledge about a word (Funnell et al., 2004).

All this means that the assessment of word learning should involve several measures that can range from whether a child can produce the correct phonological form to being able to give a definition of the target word. Another impetus for the use of more detailed measures of word knowledge stems from studies of word production (Chapter I-IV). These have highlighted that a range of different forms of lexical knowledge is involved in children being able to produce a word - from the ability to categorise a stimulus, to the ability to initiate a motor programme to produce the target word (Levelt et al., 1999). Work in this tradition can be contrasted with the predominant methodology in word learning studies which, as just mentioned, usually involves multiple choice comprehension tasks. The identification of different components of lexical knowledge necessary for production provides an additional rationale for a more detailed examination of the types of information children acquire during word learning, and indicates the types of lexical knowledge that it could be useful to assess. As a result of these considerations, it was decided to investigate lexical acquisition by assessing some of the forms of the information that are relevant for word production, and additional forms of information which offer a more detailed picture of the information that is acquired i.e. in terms of the nature and strength of the representation(s) that are created in memory (Gaskell & Dumay, 2003). Some of these forms of information have been considered in the first four chapters and further details are given in the following section.

The importance of semantic knowledge in relation to lexical processes has been demonstrated by several researchers (Nation et al. 2001). Semantic abilities have be been assessed in a number of ways, and different tasks are believed to tap into different types of semantic representations. However, there is no consensus as to which is the most appropriate measure to use. The following section describes the measures of semantic ability chosen in the current research – namely a definition task, an assessment of semantic knowledge, a drawing task and a multiple choice task,.

A *definition* task assesses children's explicit semantic knowledge and their ability to identify the critical features about a word and/or their ability to explain them to another person. Karmiloff-Smith (1992) argued that such explicit knowledge involves higher levels of representation (see also Ralli, 1999). Indeed, this "offline" task typically requires children to consciously access knowledge and is dependent on non-linguistic skills, attention, memory etc. (Shapiro et al., 1998). Because the demands of the task are high (children need to consciously access knowledge and verbalise it), it was decided to complement this task with other assessments of semantic ability. Indeed, a failure to provide a definition might simply indicate a difficulty to verbalise rather than a lack of knowledge.

Semantic knowledge often involves information about the functions or activities that are associated with the target word, where it is located, what it is made of, and its relations with other words. However, as seen above, sometimes this knowledge is not provided by children in their definitions. A *word knowledge* assessment was thus used as a complement to the definition task, and consisted in asking children questions about the specific characteristics of the target items. This task is believed to be less cognitively demanding than the provision of definitions as children are given a cue to the information that is required.

Finally, a drawing task was also used to capture aspects of semantic and visual knowledge that might not be produced in verbal accounts. Drawings are believed to provide indications of children's canonical representations of objects or categories, where visual element(s) serve to identify key semantic aspects of a word (e.g. a house is box-shaped, has a door, windows, sometimes a chimney). As Walker, Bremner, Merrick, Coates, Cooper, Lawley, Sageman & Simm (2006) claimed, drawing provides a rich source of information about participants' "*visual knowledge of objects, and about how this knowledge is represented mentally*" (p. 734). However, the use of drawings to investigate children's lexical representations is comparatively rare. One exception has been the work of McGregor and colleagues (2002a & b). These authors emphasised the role of semantic knowledge, as assessed by drawing and definitions, for successful word retrieval in 5-7 year olds.

A multiple choice comprehension task (MCT) provided a measure of receptive word knowledge. This task requires children to match a phonological form with the appropriate visual exemplar. As a result, the task provides an assessment of both phonological and semantically related knowledge.

Other assessments involving children's phonological knowledge of the target words were used. Previous studies of word learning have usually assessed this knowledge by asking children to name the target item. A less demanding means of tapping into phonological knowledge consists in assessing whether children can recognise the sound pattern of the new word. For example, Martin & Saffran (2002) found that an auditory lexical decision (examining children's ability to recognise a word), provided a useful assessment of receptive phonological knowledge (see also Gaskell, 2006; Gaskell & Dumay, 2003). The authors made a distinction between input phonological processing (requiring activation of phonological representations that children hear) and output phonological processing (requiring production of a phonological form). They found that the lexical decision task provided a "*more sensitive measure of the mapping between activated phonological nodes in the phonological network and lexical representations*" (p.134).

Lastly, an expressive picture naming task was used to assess whether children possessed sufficient knowledge about a word to enable the production of the appropriate phonological form. This task captures both semantic and phonological abilities – such as integration of the word form, knowledge about connections between different words and so on (Goodglass, 1980; Levelt et al., 1999). The retrieval of a word for production is considered a particularly demanding form of assessment. Therefore, a lack of correct response does not necessarily indicate lack of knowledge. As suggested by Funnell et al., (2004), the use of more complex tasks – such as naming and definitions may miss partial meanings.

The Sources of Phonological and Semantic Information

Studies of the lexical acquisition of young children have tended to investigate whether learning occurs when a novel word is spoken in the visual presence of the relevant referent. Indeed, the studies of the significance of joint attention (Tomasello & Todd, 1983 – with 12-13 month olds) or use of iconic gestures (Capone & McGregor, 2005 – with 27-30 month olds) were carried out to highlight this process. These studies showed that drawing visual attention to a referent enables relevant semantic information to be identified (Goldin-Meadow et al., 2001; Kelly & Church, 1998). Similar findings from older children suggest that emphasis of the targets' salient perceptual characteristics facilitates the recall of information (Best et al., 2006b – with 4-6 year olds; Kelly & Church, 1998 with 9-10 year olds).

However, even with comparatively young children, the concurrent matching of a word with its visual referent is not essential for word acquisition (Baldwin, 2000). As illustrated earlier on in the chapter, early word learning studies have shown that learning can take place in situations where the referent is not present. For example Tomasello & Barton (1994) have found that if the name of a referent was spoken, and then the experimenter held different objects while appearing to search for a special toy, children of 18 and 24 months old were able to link the word to an object which the experimenter showed pleasure at 'finding'. In their study, an experimenter pretended to be looking for an object ("*Let's find the toma*") by pulling each one by turn. In two instances, the experimenter expressed disappointment, by scowling and putting the object back. On a third attempt, the experimenter expressed glee upon picking up the novel object. Findings showed that 18 and 24 month olds were able to *read the social cues* (p. 142) and infer that the "*gazzer*" (or "*toma*") referred to the 'successful' attempt. Similar findings were obtained by Akhtar & Tomasello (1996) assessing word learning in 24 month olds. An experimenter announced an intention to find an object (or an intention to perform an action). Findings indicated that learning took place even in a condition where children never saw the referent (for example, children were told the object was locked in a barn and/or the toy character was missing). The authors concluded that word learning does not necessarily depend on the perceptual pairing (or temporal contiguity) between a referent and a word.

These doubts concerning the necessity of visual information about the referent in word learning have been accompanied by experimental findings that indicate children can make use of non-visual forms of information when learning unfamiliar verbal labels. The use of syntax to acquire new words is one of these other instances. The ability to make inferences about word meaning based on the linguistic properties of words (Bedore & Leonard, 1995; Fischer, Hall, Rakowittz & Gleitman, 1994; Hoff & Naigles, 2002) has been referred to as *syntactic bootstrapping* (Gleitman, 1990). As an illustration, Tomasello (2002) showed how grammatical constructions provided a framework for children to interpret novel words. For example, children hearing "the zav" understood that "zav" was an object. On the other hand, children who heard "the zav one" were correctly able to infer that "zav" indicated the property of an object. Similar conclusions have been reached in relation to instances of incidental learning. Indeed, using 3 to 8 year old children with SLI, Rice and colleagues found that manipulating the type of referent (object, attribute, action or affective), word class (noun vs. verb), syntactic frame (transitive vs. intransitive) and morphosyntactic cues influenced children's comprehension of words (Oetting, 1999; Oetting et al., 1995; Rice et al., 1990; 1992; 1994; 2000) and could influence the acquisition of novel words (or word meanings).

A more obvious and direct source of semantic information comes from explicit mention of the properties of words. There are indications that children can benefit from a range of semantic cues such as the use of analogies or inclusion statements such as "*An X is a kind of Y* (the latter being a familiar label)" (Goodman, McDonough & Brown, 1998; Horohov & Oetting, 2004). Other semantic cues believed to facilitate word learning consist in using definitions (Best et al., 2006b; Nash & Snowling, 2006) or synonyms (Clark & Wong, 2002). For example, Brett et al. (1996) assessed vocabulary gains from 9-10 year olds after listening to stories with 25 unfamiliar words (e.g. *despondency*, *bereft*, *noxious*). Significant vocabulary gains were observed in the condition where children heard the novel word accompanied by a brief explanation (e.g. "*Despondency is a feeling of being discouraged or hopeless*") compared to the conditions where this information was absent.

Consequently, it would appear that although visual information is often present in word learning settings, word learning can occur in the absence of such information and be based instead on other sources of information. Of particular importance is the fact that older children seem to learn a lot from incidental contexts where the referent is not necessarily present – e.g. Nagy et al., 1987. An interesting question thus concerns the extent to which primary school-age children can learn in the absence of a visual referent. To date, there remain uncertainties regarding the way that different forms of information (semantic and visual) affect the different forms of lexical knowledge that children gain from their experiences. Furthermore, it would be interesting to examine whether performance on some tasks is dependent on the type of information (or input) that children receive. For example, it might be anticipated that the provision of semantic information would be related to tests of lexical knowledge involving definitions and/or word knowledge. In contrast, visual information would be related to certain aspects of lexical knowledge such as drawings and/or recognition of the visual form of the target. The two subsequent chapters report investigations that address these issues.

III. Aim of Word Learning Studies

The current research was initiated because of a need to understand more about a child's lexical system, and the nature of their developing representations during a word learning task in an incidental context. The focus is on typical populations so as to extend knowledge of the processes of lexical acquisition in school children. A useful method for studying the lexical system in these children was developed by Rice and colleagues (Rice, 1990; Rice & Woodsmall, 1988). It was decided to adapt the QUIL paradigm in order to be able to manipulate the type of input presented to children. In this way it will be possible to gain insight into the types of input that influence lexical acquisition and/or the nature of the representations that develop during learning. Questions will be addressed concerning the usefulness of visual and semantic information and how each type of information affects different components of lexical knowledge, as assessed by a range of tasks involving different types of lexical abilities – such as information about the novel words' phonological form, its semantic properties and/or salient visual characteristics.

CHAPTER VII

WORD LEARNING PT.I

I. INTRODUCTION

The current research addresses issues raised in Chapter VI, by bringing together models and methodologies involved in the study of word learning and word production. Most of the work on lexical acquisition comes from early childhood (Tomasello et al., 1996; Tomasello, 2001), from studies comparing language-impaired children and typical peers (Rice & Buhr, 1992; Horohov & Oetting, 2004) or from explicit classroom teaching (Beck et al., 1982; Carlisle et al., 2000). Less attention has been paid to typical learning processes of school-age children, particularly in incidental learning contexts i.e. where the meanings of novel words are not formally, or explicitly, taught. It is important to identify the factors supporting later acquisition as these children are sensitive to cues and/or guidance about word meanings (Bauman & Kameenui, 1991) and it is also a period when children encounter challenging topical words in classroom settings (Wilson, 1998). Three main issues addressed in this investigation concern (i) the nature of the lexical representations formed during word learning; (ii) whether learning occurs and whether different forms of input influence lexical acquisition; and (iii) the role of child-based factors in relation to word learning performance. These are discussed below.

1.1. Forms of Lexical Knowledge Acquired in a Word Learning Task

Different component processes have been identified in models of lexical access and word production (see Chapter I). The dominant view (Levelt et al., 1999; Caramazza, 1997) is that both semantic and phonological processes are involved. In picture naming, processing of the pictorial stimulus occurs first (Johnson et al., 1996). Children then draw on information from the lemma (semantic representations) and from the lexeme (phonological representations) levels (Levelt et al., 1999). Word learning starts with the reverse flow of information to that occurring in word production. According to several researchers (Gershkoff-Stowe & Hahn, 2006), an auditory cue provides a basis for the encoding of a phonological representation in memory; activation then spreads to the semantic level where children need to make connections between this novel label and other representations (Booth & Waxman, 2002). The similarity of the component-processes involved in word production and word learning provides a rationale for the choice of tasks used in the current research. These tasks assess the information children possess which is relevant for word production, but also assess children's general knowledge of the new words such as the information pertinent to a word's phonological form, semantic properties, or its physical characteristics (see Funnell et al., 2004) for distinction between children's ability to name novel words and their ability to manifest lexical knowledge about these words).

Assessing lexical knowledge

In the current research, it was decided not only to assess production abilities (i.e. naming) but also other related aspects of lexical knowledge. These include assessments involving children's *receptive* abilities (typically assessed by MCTs and where children point to a target or say yes/no to its presence) and *expressive* abilities (requiring children to provide a name or a definition for the new words; e.g. Kameenui et al., 1982; McKeown et al., 1985). It is believed that both types of measures involve different cognitive processes and place different demands on children's processing abilities (Nash & Snowling, 2006; Senechal, 1997). *Comprehension* merely assesses a child's ability to <u>recognise</u> an unfamiliar sound pattern upon hearing its label and then retrieve a mental representation (Gershkoff-Stowe & Hahn, 2006; Huttenlocher, 1974). On the other hand, naming (or the <u>retrieval</u> of words for production), requires children to associate its phonological representation with a given meaning. Because fewer cues are available for retrieval (Barsalou, 1999b), production tasks are believed to be more demanding and to require stronger activation (Capone & McGregor, 2005) than tasks involving comprehension. As a result, one would thus expect scores on tests of receptive ability (e.g. lexical decision or comprehension tasks) to be higher than scores on measures of expressive ability (also see Donaldson & Laing, 1993). It was thus decided to include assessments involving both comprehension and production of the target words (see Table 1 for a summary of the main measures of lexical ability used in the current study). Moreover, following the methods used in previous chapters on naming processes (Chapters I to IV), it was also decided to record response times whenever possible. Specifically, measures of speed of response could give an indication of the strength of connections formed during word learning, where stronger connections would be expected to result in quicker, and more accurate, retrieval of information. The analysis of response times is rarely used in developmental approaches of word learning but is nevertheless believed to provide an additional methodological tool for understanding more about lexical knowledge.

Table 1: Measures of lexical knowledge used in the current investigation

Type of task	Ability measured
SEMANTIC	
MCT [receptive]	Ability to identify target items by recognizing pictures from a set of visual distracters.
Definition [offline / expressive]	Explicit knowledge of word meanings
Word knowledge [expressive]	Knowledge of general characteristics of target items
Drawing [offline / receptive]	Knowledge of the visual properties of the target(s)

PHONOLOGY Lexical Decision [receptive]	Ability to recognize the phonological form (sound structure) of the target word(s) from a set of auditory distracters.
NAMING Picture naming [expressive]	Ability to retrieve the name of novel items for production

1.2. Role of Semantic and Visual Information as Assisting Word Learning

A second issue concerned the effects of visual and semantic input on word learning. As already discussed (see Chapter VI for details), the majority of studies investigating word acquisition have involved the referent being present and the learning situation has often consisted of drawing attention to the association between the phonological label (novel word form) and its referent – e.g. by pointing to the object (Goldin-Meadow, Nusbaum & Kelly, 2001) or contrasting the novel item with a familiar one (Carey & Bartlett's (1978) instruction about "*not the chromium one, the blue one*"). Nevertheless, word learning is believed to occur in those situations where the referent is not present (Fischer et al., 1994; Horohov & Oetting, 2004). However, this aspect has rarely been investigated with typical children of school age. In addition, uncertainties remain about the importance of visual information in relation to semantic information because direct comparisons of the effects of these two input modalities on word learning do not appear to have been made, especially in relation to contexts where the new words are not formally taught. In order to understand more about the effect of visual and of semantic information on word learning, it was decided to manipulate the provision of these two types of contextual inputs.

A useful methodology to examine word learning in older children is the QUIL paradigm developed by Rice and colleagues (Rice, 1989; 1990a & b & c; Rice & Buhr, 1992). It was decided to use this experimental paradigm because of its ability to simulate naturalistic learning contexts. As Rice (1990; p. 179) summarised, the QUIL paradigm enables researchers to manipulate the presentation of the information in "careful controlled experimental" conditions. In the current research, the number of exposures of each novel target word remained constant. Perusal of the existing literature showed that there was no consensus on the 'best' number of repetitions, though these numbers varied between 4 to 14 (see Table 1 in Chapter VI for details of main QUIL studies) depending on the number of words introduced and the age of the children assessed. Again, according to Rice and colleagues, presentation rate of 5 to 7 for each word (Rice, 1990c; Rice & Woodsmall, 1988) are believed to be a rate consistent with the "*rate of targeted words in educational programmes*" (Rice & Haight, 1986). In the current research, it was therefore decided to introduce 8 repetitions for each of the 5 novel words.

This design provides the opportunity to investigate whether semantic input can be as effective as visual input in assisting word learning, as well as whether different sources of information (semantic vs. visual) affect the different forms of lexical knowledge and representations that are acquired. Gray (2005) examining 4-5 year olds on a fast mapping task hypothesised that "*different cues may aid different aspects of word learning*" (p.1452). In this study, children were in one of two conditions: a semantic condition where information was provided about the object's superordinate category, function or association (e.g. The *haymut* was described as "*A kind of turtle* (superordinate), "*It crawls* (action)" or "*It's kind of like a tortoise* (association)"). On the other hand, children in the phonological condition were provided with information about the sound structure of the target (e.g. "*It starts with /h/*" (initial sound), "*It starts with /he/*" (initial syllable) or "*It rhymes with /hemat/*" (rhyming)). Findings showed that being given explicit semantic information made a significant difference on the comprehension task. In contrast, being given information about the sound structure of the novel word enhanced subsequent production of the novel words (see also Ralli, 1999; Funnell et al., 2004). From findings such as these, several predictions can be made. One might expect the provision of semantic information in the Speech condition to affect performance in some of the semantic tasks – e.g. definition and word knowledge, because children are given explicit information about the target item. One might also anticipate children in the Speech condition to be at a considerable disadvantage in drawing, naming and/or comprehension as these tasks rely more or less heavily on visual information and children in this condition will not have seen what the object looks like (again, this argument has been put forward by Funnell et al., 2004). On the other hand, if there is cross-modal transfer between different modalities, children in the Speech condition ought to be able to translate this knowledge into different formats.

1.3. Characteristics of Children that are related to Word Learning

The type of information supplied in word learning contexts can be an important determinant of what forms of knowledge are acquired about new words (Baumann & Kameenui, 1991; Gray, 2005). However, successful word learning is also dependent on children's characteristics. A third aim of the study therefore examined whether children's general abilities (in relation to semantics and phonology) were related to word learning performance. Previous research has identified some abilities that appear to be related to word learning (e.g. see Bloom, 2001a & b; Leung & Pikulski, 1990; Senechal et al., 1995). Guided by the existing literature, it was decided to assess four main types of abilities. Two of these are measures of phonological ability (phonological awareness and phonological short-term memory), two other measures assess aspects of semantic knowledge (semantic fluency) and both phonology and semantics (as measured by receptive vocabulary). The rationale for selecting these assessments is presented below.

The association between memory and vocabulary growth has been investigated through a series of articles by Gathercole and colleagues (Gathercole & Baddeley, 1991). There is evidence that the ability to store information on a temporary basis, as assessed by nonword repetition, is related to vocabulary size and to language acquisition (Bowey, 2001; Ellis-Weismer et al., 2000; Gathercole et al., 1992; 1993; 1999). Through these investigations, Gathercole and colleagues concluded that children with good skills at repeating nonwords possessed greater knowledge of words (vocabulary size) than children with poor nonword repetition skills. For instance, Gathercole & Baddeley (1989) found that 4 year olds' nonword repetition skills were a reliable predictor of vocabulary acquisition one year later. There is additional evidence that nonword repetition was related to children's ability to learn new words (Jarrold, 2004; Martin & Gupta, 2004; Michas & Henry, 1994). Similar findings were found in relation to learning a second language (Service, 1992; Service & Kohonen, 1995). For these reasons it was decided to include a nonword repetition task and examine its relation to children's word learning performance.

Phonological awareness involves the ability to identify the constituent sounds of words, and may help with the integration of new words into the larger vocabularies of primary age children. Indeed, according to Thomson et al. (2005), performance on phonological tasks is believed to "*provide an index of the representational adequacy of a child's long-term phonological representations*" (p.1212). This ability has been found to be related to the growth of children's vocabulary (Metsala, 1999) and to phonological short-term memory (Bowey, 1996; Gibbs, 2004). For example, De Jong, Seveke & van Veen (2000) found that phonological awareness (as assessed by sound categorisation and detection tasks) in 4-6 year old children was strongly related to children's ability to learn unfamiliar words (see also Metsala, 1999). Windfuhr & Snowling (2001) also highlighted that measures of phonological awareness were better predictors of nonword learning than phonological short-term memory skills. The current research included both types of task to assess the strength of their relationship with word learning performance.

Two other assessments were related to semantic knowledge and were relatively quick to administer. Assessments of *semantic fluency* give an indication of the strength of association between items in the child's lexicon. A link has been found between word production (naming ability) and children's scores on the fluency task (Dockrell et al., 2001). It is thus interesting to investigate this relationship in a learning context. The *BPVS* was used as a receptive measure involving both a semantic and a phonological component. There is evidence that vocabulary is a reliable predictor of children's ability to learn new words. This has been demonstrated by several studies. For example, Gathercole et al. (1997) examining 5 year olds on 4 word learning tasks found that children's ability to learn new phonological forms (such as *drattle*, *bleximus* etc.) was highly related to existing vocabulary knowledge. Additional evidence that children's initial level of vocabulary knowledge was a reliable predictor of vocabulary gains (or ability to learn novel words) comes from studies investigating learning in incidental contexts. For instance, through two experiments, Senechal et al. (1995) found that 4 year old children who possessed large receptive vocabularies learned more words, such as *fedora* or *slumber*, than children with smaller vocabularies. Penno et al. (2002) found similar findings from the examination of 7-8 year old children. More recently, Nash & Donaldson (2006) examined the importance of possessing adequate vocabularies for successful word learning. The authors investigated 5 to 9 year old children with SLI on a word learning task where the novel words were either presented in a story context (incidental) or via direct or explicit teaching. Their findings showed that children with vocabulary deficits had significant problems to establish novel word forms in memory, compared to their typical matches.

1.4. Research Questions

The current research aimed to examine children's learning of new object labels. Three specific issues will be addressed.

1. Whether, after word learning, some forms of lexical knowledge are more difficult to access than others.

2. Whether learning took place when target words were presented during a story, and whether visual and/or semantic input has a differential impact on the types of representations children form.

3. Whether child characteristics are related to the success of word learning.

II. METHODOLOGY

2.1. Participants

Thirty-one children (mean age in months = 106; SD = 3.89) were recruited from a mainstream school in South East London. The sample comprised 16 boys and 15 girls. Teachers selected children that were of mixed academic ability.

2.2. Design

A between subjects design was used. Children were randomly assigned to one of three conditions. All children heard the same basic story which contained the same 3 novel words.

In the Visual condition children were given a picture about the referent of each novel word. In the Speech condition, children were given explicit semantic information. There also was a third condition in which children were given a picture about the referent, as well as information about the type of object etc.

Table 2: Characteristic of children in each of the three experimental conditions

Experimental group	**Age (in months)**	**Gender**
Group 1 [Visual = V]	M = 105.58; SD = 1.30	5 Girls & 7 Boys
Group 2 [Speech = S]	M = 106.90; SD = 1.28	6 Girls & 4 Boys
Group 3 [Combined = V + S]	M = 105.44; SD = 2.96	4 Girls & 5 Boys

2.3. Apparatus and Procedure

2.3.1. Materials –The Stories used in the 3 Conditions

A story was constructed about a main protagonist, *Sammy the rabbit,* who went on a trip around the world and encountered three unusual objects. The story was presented on a laptop and heard via headphones. The task was set up using the SuperLab-Pro software for Windows (Cedrus & Chase, 1990). There were three referents in the story which were fantasy objects with novel names. Prior knowledge was thus controlled by the use of nonsense words.

Children listened to a short narrative about each of these referents, in the same fixed order (see Appendix I for script of stories heard). The three nonsense words were taken from nonsense words were taken from Masterson's list (1989) and were: *celtar,* representing an oddly-shaped tree; *genum,* an oddly-shaped animal and *inlect,* an oddly-shaped house. Phonological factors and the number of exposures were kept constant (each novel word was repeated 8 times). The provision of semantic and visual information was manipulated to produce three conditions (see Appendix I for storyline script). The stories in each condition ran for approximately 6 minutes. The three conditions are presented in detail below.

Visual condition [*V*]: Each time children heard the novel label, a coloured picture was simultaneously presented on-screen to accompany Sammy's narrative. In this condition, children were merely presented with general elements of description and pictorial stimuli to illustrate these. No information about meaning(s) or class/category membership was included. Example of storyline for the celtar (which represented a novel tree): "*This is a "celtar". Look at this tall "celtar", Sammy had never seen anything quite like this before (picture shown).*

Speech condition [*S*]: These children heard the same story but without any visual information. Instead, presentation of the novel word was accompanied by descriptive information (see below) and also explicit information relating to the word's meaning (by use of analogy and information about category membership). Example of storyline: "*Sammy first saw a "celtar". The "celtar" is a kind of very tall wooden plant that Sammy had never seen before".*

Combined condition [*V* + *S*]: These children heard the story presented on the speech condition and the pictures presented in the visual condition. Example of storyline: "*Sammy first saw a "celtar". The "celtar" is a kind of very tall wooden plant that Sammy had never seen before".*

2.3.2. Word Learning Assessments

Children were assessed on several dimensions of lexical competence. They were instructed to answer as quickly as possible, without sacrificing accuracy. A complete set of instructions and material used can be found in Appendices I and K. This section provides a description of the materials used, as well as the appropriate procedure. The tasks administered to children followed the same (fixed) order as described below. The rationale for ordering tasks was to try to ensure that performance on earlier tasks did not facilitate or contaminate performance on the latter tasks.

2.3.2.1. Picture Naming

A discrete picture naming task was used to examine whether children possessed sufficient knowledge about a word to enable the retrieval from memory.

Apparatus: 15 coloured pictures were used. These consisted of 3 drawings of the novel imaginary objects (*celtar*, *genum* and *inlect*), 3 pictures representing real objects from the same category (i.e. picture of a tree, an animal (*dog*) and a house (*inlect*), and 3 distracter pictures that were modifications of the initial target pictures (i.e. a *celtar* without the branches, a *genum* without fangs/tusks, an *inlect* with a different shaped roof); 6 other distracters representing invented objects were also used. Pictures were scanned and integrated into the computer program.

Procedure: Pictures appeared randomly, one at a time, in a central position on the screen and remained until they were named. Children were required to name them as quickly and accurately as possible: "*You are going to see some pictures on the screen, one at a time. Tell me the name of the picture as quickly as you can, but without making mistakes. If you don't* *think there is a name for the picture, or if you have never seen this picture in the story, just say "No name"* (instructions were modified for the second condition *"if this picture was not from the story")*. The experimenter pressed a key according to the accuracy of response (key "a" for error, "q" for correct and "z" for "no name"). The start and end of each session was signalled both visually (display on-screen) and verbally (by the experimenter). **Data recording:** Answers were coded as +1 or 0, with a maximum of 3 for each child. Speed of response was recorded by the software.

2.3.2.2. Lexical Decision

An auditory lexical decision task was used to assess children's phonological recognition of the novel words, when competing distractors were present.

Apparatus: Fifteen words were used. These were the 3 novel labels used in the story (*celtar*, *genum* and *inlect*); 3 real/related words (*tree*, *animal*, *house*); 3 words that sounded the same as the targets, but with modification to the final sound (*celtium*, *gesail*, *intobe*) as was carried out by previous work into the process of lexical acquisition (e.g. see Gaskell & Dumay, 2003); 4 nonsense sounds never encountered before (*klower*, *kloneg*, *girter* and *girdon*) and 2 real words chosen at random (*instrument* and *car*). This task was implemented by using the SuperLab-Pro software (Cedrus Chase, 1990).

Procedure: The words were presented in a random order for each child and were heard via the use of headphones. Children were instructed as follows: "*You are going to hear some words, one at a time. Some of the words are the names of the items that Sammy saw on his trip around the world. Tell me if you have heard this word before in Sammy's story: are these names of the objects that Sammy saw?" Say "YES" if it is an object that Sammy saw; say "NO" if it is not an object that Sammy saw. Try to be as quick as you can, but without making* *mistakes.*" Children's responses were recorded by the experimenter pressing colour-coded keys: "q" if children said "yes" and "a" for "no". The start and end of each session was signaled both visually and verbally. **Data recording:** Responses were coded as +1 or 0, with a maximum of 3 per child. Speed of response was also recorded by the software.

2.3.2.3. Verbal definitions

Apparatus & Procedure: Children were asked to provide meanings for each of the novel words. The words were presented orally, in a random, order as follows: "*Now, I am going to say a word, and I want you to tell me what the word means. Tell me everything you know about it. Try to be as quick as you can. Are you ready?*" **Data recording:** Accuracy was scored in terms of the number of correct elements of responses using a coding grid (see Table 3). Response times were recorded with a stopwatch and consisted in the duration from the onset of a child's utterance to the end of their response.

Table 3: Coding grid for verbal definition task

CATEGORIES	DEFINITION
Perceptual	Types of responses describing the target's descriptive characteristics, features or working parts. For example: "*It has sharp teeth*" (for the animal); "*It has red spots on top*" (for the house).
Semantic category membership	Types of responses that provide information about the type of relationship with the target word. These can consist of superordinate (e.g. "*It's a house*", "*It's a tree*" etc.) or coordinate (e.g. "*It's a type of dog*") levels of association.
Association or analogies	Types of responses that are based on similarities between the target word and a child's response. For example: "*It looks like a man*" (for the tree); "I*t is like a mushroom*" (for the house).
Functional	Types of responses that provide information about the possible uses one can make of the item, or what the item can do. For example: "*You can sit on it*" (for the tree); "*You can sleep in it*" (for the house); "*You can eat it*" (for the animal).

Location	Types of responses that provide information as to where one can find the target items. For example: "*It lives in a zoo*" (for the animal); "*It is in the countryside*" (for the tree).
Acceptable Inference	Types of responses that include plausible extrapolations or inferred answers consistent with the storyline. For example "*The genum* (animal) *is friendly when you give it food*"; "*You can find it in neverland*". This information is not specified in the storyline but is consistent with the nature of the animal/characteristic of the target, as described in the story.
Other	Types of responses that consist of either "*Don't know*" responses, wrong identifications of a target (saying it is a tree when defining the animal), irrelevant or incoherent responses (e.g. "It's a girl").

2.3.2.4. Word knowledge

Apparatus & Procedure: Children were asked to provide further information about the targets' attributes – namely, category membership ("*What sort of group does it belong to?*"), functional ("*What can we do with it?*"), locative ("*Where can you find it?*"), perceptual ("*Can you describe it?*"), compositional ("*What is it made of?*") and analogy (*"What else is like this object?"*). The types of questions asked, and how these were coded, are presented in Table 4 below. **Data recording:** The total number of correct responses was calculated for each word and for each child.

Table 4: Coding grid used for the word knowledge assessment

DIMENSIONS ASSESSED	WORD KNOWLEDGE ASSESSMENT
Semantic category "*What sort of group does it belong to*"	Correct responses include adequate category membership responses from superordinate or coordinate levels of association. For example: "*It is a tree*", "*It is a type of animal*" etc.
Functional "*What can we do with it?*"	Correct/acceptable responses include answers that are from the story "*You can eat it*" (for the animal) or responses that are consistent with the novel words "*You can climb it*" (for the tree) or "*You can go on the roof*" (for the house).

Locative *"Where can you find it?"*	Correct responses include answers taken from the story – e.g. "In a forest" (for the tree), "In the countryside" (for the house). Acceptable responses include answers that are plausible, even though not specified in the storyline – e.g. "It is outside" (for the tree), "Where there are animals/neverland" (for the animal).
Perceptual/descriptive *"Can you describe it?"*	Correct/acceptable responses include descriptions of the item that is taken from the story – e.g. "*It is wide like this* (gesture) *and ends with feet*" (for the tree), "*It has big ears and likes to play*" (for the animal).
Compositional *"What is it made of?"*	Correct responses include the following: wood (for the tree), skin/blood (for the animal), brick/wood (for the house). Acceptable responses correspond to elements that are related to the targets' internal composition or constituent parts – e.g. "*Nature/leaves/seeds*" (for the tree), "*Hearts/meat*" (for the animal.
Analogy *"What else is like this object?"*	Correct/acceptable responses consisted in answers where a (direct) relationship was present between novel target and child's answer. For example: "*It looks like a normal tree*", "*It looks like a man*" (for the tree); "*It looks like a dog*" (for the animal); "*It looks like a mushroom*" (for the house).
Other	Types of responses that consist of "*Don't know*"; identification of the wrong category e.g. "*It is a flower*" (for the tree) or "*It is a mouse*" (for the animal); or non-specific responses (e.g. "*It is made of soft stuff*") and so on.

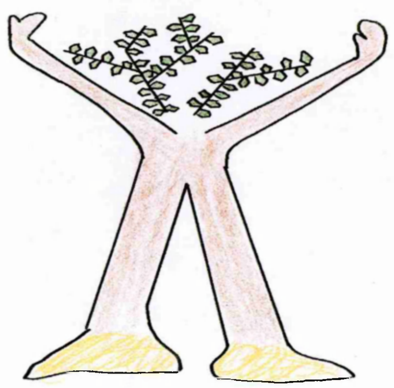
2.3.2.5. Drawing

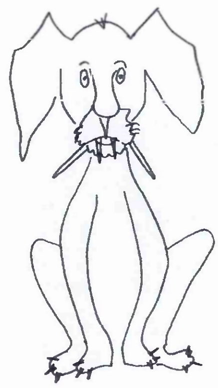
Apparatus: Children were provided with sheets of paper (one for each drawing) and pencils.

Procedure: Children were instructed as follows: "*Now, we are going to play another game. I am going to ask you to draw some objects for me. Don't take too much time as I will be timing you, but try to be as accurate as possible. Are you ready? Go!*"

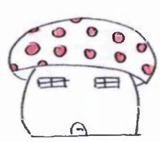
Data recording: Accuracy was assessed by use of a coding grid which awarded +1 point for each salient perceptual characteristic that children included in their drawings. Thus, children could score a total of 15 points [5 points per target]. The total time taken to complete a drawing was recorded via a stopwatch (in milliseconds) – starting from the moment a child put pen to paper and started to draw.

Table 5: Coding grid used for the drawing task

TARGET(S) & TOTAL NUMBER OF POINTS	DRAWING & ALLOCATION OF POINTS
TREE [5 points] 	• 2 trunks apart --- +1 • Letter A shape (part of storyline) --- +1 • Shoes at bottom --- +1 • Leaves --- +1 • 2 branches apart--- +1

<table>
<tr>
<td>ANIMAL [5 points]
</td>
<td>

2 ears --- +1
2 fangs --- +1
2 elephant tusks --- +1
Facial features (eyes, nose, whiskers, shape of face) --- 0.25 x 4
Additional features: general outline of body, legs, claws, tail --- 0.25 x 4

</td>
</tr>
<tr>
<td>HOUSE [5 points]
</td>
<td>

Roof and red spots --- +1
Shape of building (large at bottom, slightly narrower on top) --- +1
Door and windows --- +1
Platform --- +1
Additional features(seen/heard in story): ladder, wheels, someone pulling with ropes, legs of platform --- 0.25 x 4

</td>
</tr>
</table>

Scorer reliability: All drawings were coded immediately after the testing session. In order to establish coder reliability, half the children's drawings (i.e. roughly 16) were chosen at random and re-coded 2 years later. Correlations between the initial scores and the new coding were strong ($r = .749$; $p = .001$) and the percentage of pictures that were scored within 1 points of one another was 81%, thereby reflecting consistency in the application of the coding grid.

2.3.2.6. Forced-choice comprehension

Apparatus: A set of 10 pictures was presented on a laminated A4 card (3 target pictures encountered in the storyline and the 7 distracters which consisted of slight modifications to the target pictures, i.e. by excluding one or two salient features. Children were instructed as follows: "Now, *I will say a word. Look carefully at all the pictures and point to the picture that matches the word/is the thing in the picture. Which is the best match? Try to be as quick as you can. Are you ready? Where is the "X"* (start stopwatch). The experimenter signalled the start and end of each session verbally. **Data recording:** Accuracy of response consisted in awarding +1 point for each correct identification (maximum out of 3). Latency of children's responses was recorded via a stopwatch (in milliseconds) after the instruction.

2.3.3. Standardized Language Assessments

Children's semantic and phonological abilities were assessed by the following tasks.

Receptive vocabulary: Children's receptive vocabulary was assessed via the British Picture Vocabulary Scale (BPVS; Dunn, Dunn, Whetton & Pintillie, 1992). Children were required to pick the correct target out of a set of 4 pictures. Raw and standardized scores were calculated according to the methods described in the manual.

Phonological awareness: Children's phonological skills were assessed via 2 sub-tests of the Phonological Assessment Battery's (PhAB; Frederickson, Reason & Frith, 1997). Children were instructed to pick the 2 words out of 3, presented orally, that either shared the same initial sound ("*alliteration*") or the same sound at the end ("*rhyme*"). Accuracy consisted in the total number of correct responses (maximum out of 31).

Semantic fluency: Children's ability to search their internal lexicon rapidly and automatically was assessed by another sub-test from the PhAB. Children were required to list as many words belonging to a stated category as they could think of, in the space of 30 seconds (i.e. *things at school*, *animals* and *things to eat*). The number of correct responses was scored.

Short-term phonological storage: The Children's test of Nonword Repetition (CnRep; Gathercole, Willis, Baddeley & Emslie, 1994) was used to provide a measure of children's short-term phonological storage skills. Children were instructed to repeat 40 nonsense novel words varying from 1 to 4 syllables immediately after the experimenter. Accuracy of response corresponded to the number of correct repetitions (maximum out of 40).

2.3.4. Procedure

Children were assessed individually, in a quiet environment on the school premises. Each session lasted about 40 minutes. In each session, children first saw/heard the stories on screen. This was followed immediately by the administration of the word-learning tasks (described in section 2.3.2.), so as to assess learning. Finally, children's performance on standardised language assessments (section 2.3.3.) was examined last.

Analysis of response times: Statistical analyses were carried out on correct responses. All error responses were identified as missing data, and were subsequently excluded from the data set. Outliers were not excluded because, due to the nature of the task (i.e. learning situation), some children have longer response times when they have difficulty correctly recalling a novel word or retrieving other information. It was decided to include these in the analyses as these correct longer responses indicate when children experience problems accessing the information they have learnt. Because of this decision, non-parametric statistics were used for analyses on response times. Accuracy scores were analysed by the use of parametric tests.

For a response to be coded as correct, children had to pronounce the word at it was initially presented (i.e. 100% accurate).

II. RESULTS

The three issues addressed are whether some forms of lexical knowledge were more difficult to access than others; whether learning occurred and whether there were significant differences across conditions; and finally whether children's abilities were related to their learning.

3.1. Access to Lexical Knowledge

A repeated measures MANOVA was used to see whether scores on the different measures of lexical ability differed significantly from one another. The maximum score on the picture naming, comprehension and lexical decision was 3 (1 point awarded for each of the three targets). In contrast, the drawing, definition and word knowledge tasks could receive scores greater than 3 as children could provide several correct answers about each target. In order to have comparable scores across all 6 measures, accuracy data on the definition, word knowledge and drawing tasks (which were initially coded to give the total number of correct responses) were transformed for this analysis. One point was awarded when a child provided any correct answer for each of the three targets.

Table 6: Word learning performance across tasks (data ordered from lowest to highest scores)

	Mean [total out of 3]	Standard Deviation
Picture Naming	0.65	.915
Definition (out of 3)	1.61	1.145
Comprehension	1.94	1.063
Word Knowledge (out of 3)	1.97	1.110
Drawing (out of 3)	2.03	1.224
Lexical decision	2.29	.902
Definition (raw score)	5.06	4.837
Word knowledge (raw score)	13.13	9.684
Drawing (raw score)	4.87	3.729

The MANOVA revealed a main effect of the type of task: $F (5, 150) = 13.191$; $p < .001$. This difference was considered to be a large effect, with a partial Eta squared value of $\eta p^2 = .305$. Analyses showed that (a) scores on the picture naming were significantly lower than scores on all the other dimensions of lexical ability ($p < .001$); (b) scores on the definition task were significantly lower than scores on the lexical decision task ($p < .001$; with Bonferroni corrections $p = .077$).

3.2. Effect of Condition on Word Learning Performance

Before examining whether children's performance was different across conditions (Visual vs. Speech vs. Combined), an analysis was conducted to see whether children had gained information from the stories about the 3 target items. A one-sample t-test was used to determine whether there was evidence of learning in relation to each of the assessments. The comparison value was set at zero for the picture naming, definition, drawing and word knowledge tasks as children cannot guess the answer (they either know it or not). On the other hand, children could produce the correct answer by chance on the lexical decision task (2 alternatives to choose from: yes/no) and on the comprehension task (10 alternatives to choose from). In these two cases, it was decided to use a different comparison value so as to account for chance – namely, .10 for the comprehension task and .50 for the lexical decision task). As summarised in Table 7 (see below), analyses indicated the presence of significant differences on all measures of lexical ability between the actual and expected scores, thereby confirming that learning took place.

Table 7: Output for the one-sample t-test on all measures of lexical ability

Word learning tasks [max score out of 3]	Mean (SD)	T-value	Cohen's D* Effect Size
Picture Naming	0.65 (.915)	t (30) = 3.927; p < .001	d = 0.70 – medium effect
Lexical Decision	2.29 (.902)	t (30) = 11.056; p < .001	d = 1.98 – large effect
Comprehension	1.94 (1.063)	t (30) = 9.618; p < .001	d = 1.72 – large effect
Definition	1.61 (1.145)	t (30) = 7.841; p < .001	d = 1.40 – large effect
Word Knowledge	1.97 (1.110)	t (30) = 9.870; p < .001	d = 1.77 – large effect
Drawing	2.03 (1.224)	t (30) = 9.242; p < .001	d = 1.66 – large effect

*** Cohen's Effect Size calculated as follows: d = (mean difference / SD)**

Moreover, in the case of the lexical decision task, it was possible to investigate whether children could discriminate between the items that were the target words (i.e. in a correct answer children said 'yes' to indicate this was one of the target words) and those items that were modifications of the novel target words (i.e. where children had to say 'no' to correctly indicate that this was not one of the target words). A comparison using a related t-test showed a significant difference between the frequency with which children correctly identified the new words they heard (i.e. target items such as 'celtar') and the frequency with which they (incorrectly) responded that the non-target word they heard (e.g. celtium) was one of the target words - [t (30) = -2.517; p = .017]. This shows that the new word forms had been learnt. If the children had responded randomly, no significant difference between these two sets of answers should have been found.

3.2.1. Effect of Condition on Accuracy

One-way ANOVAs were carried out on each task to see whether there were significant differences between the three conditions (see Table 8).

Table 8: Mean number of correct responses (and standard deviations) across the three conditions

Word learning Assessments	Visual V	Speech S	Combined V + S	Mean score	Sig. (2-tailed)
Picture Naming* [3 targets]	.75 (1.055)	.50 (.850)	.67 (.866)	.65 (.915)	$F (2, 28) = .196; p = .823$
Lexical decision* [3 targets]	2.00 (.739)	2.40 (1.265)	2.56 (.527)	2.29 (.902)	$F (2, 28) = 1.092; p = .349$
Comprehension* [out of 3]	1.83 (1.030)	1.50 (1.179)	2.56 (.726)	1.94 (1.063)	$F (2, 28) = 2.703; p =$ <u>.084</u>
Definition* [total number of items correct]	4.67 (4.228)	2.90 (3.665)	8.00 (5.679)	5.06 (4.837)	$F (2, 28) = 3.072; p =$ <u>.062</u>
Word Knowledge* [total number of items correct]	10.08 (9.931)	12.40 (9.324)	18.00 (8.775)	13.13 (9.684	$F (2, 28) = 1.861; p = .174$
Drawing* [total number of items correct]	4.72 (3.500)	2.82 (3.164)	7.33 (3.459)	4.87 (3.729)	$F (2, 28) = 4.220; p =$ **<u>.025</u>*** [S < V+S]

(*) Equality of variances verified through Levene's statistic (which was non-significant)

Overall, children in the Combined condition had higher scores than the two other groups. In one instance, namely in relation to the drawing task, this difference was significant. In two other instances (comprehension and definition), the difference approached the .05 significance level. The significant difference observed is attributable to the poor performance of children in the Speech condition – which had the lowest mean scores on 4 out of the 6 assessments. Interestingly, although performance of children in the Speech condition was poor, they were nevertheless still able to do some drawings, name pictures and recognize the visual form of the target in the comprehension task. In addition, the provision of semantic information in the Speech condition did not appear to significantly help performance on the semantic tasks – namely, on the definition and word knowledge.

3.2.2. Effect of Condition on Response times

Analyses were carried out on response times to see whether differences in patterns of response could be observed. In the current research, *latency of response* or how quickly a child responded was recorded (i.e. picture naming, lexical decision, comprehension). In the other tasks, the *duration of a response* was recorded (i.e. definition and drawing). Owing to the variability of response time measures (because outliers were included), non-parametric statistics were used on response times. The Kruskal-Wallis test for K independent samples indicated a lack of significant difference across conditions (see Table 9). This suggested that speed of response was not influenced by the type of condition. There was however one difference that approached significance in relation to the comprehension task, where children in the Speech condition appeared to be much slower than children in the other groups.

Table 9: Mean response time (and standard deviations) across the three conditions (analyses were carried out on correct responses only)

Word learning Assessments*	**Visual V**	**Speech S**	**Combined V + S**	**Mean score**	**Kruskal-Wallis: Chi-square test**
Picture Naming* [3 targets]	4076 (1013.159)	5436 (2391.267)	6410 (3413.728)	5194 (2390.190)	$X^2(2) = .831; p = .660$
Lexical decision* [3 targets]	811 (609.652)	543 (300.437)	1246 (1777.951)	874 (1085.312)	$X^2(2) = 1.587; p = .452$
Comprehension* [out of 3]	5213 (5096.122)	9870 (6624.888)	4391 (3489.915)	6147 (5388.161)	$X^2(2) = 5.928; p = .052$
Definition** [total number of items correct]	12769 (4931.025)	13074 (3208.669)	13135 (5508.260)	12995 (4546.068)	$X^2(2) = .035; p = .987$
Drawing** [total number of items correct]	44135 (18302.550)	47635 (11632.898)	48123 (18368.924)	46505 (16335.617)	$X^2(2) = .111; p = .946$

*** Latency of response recorded in milliseconds**
**** Duration of response recorded in milliseconds**

3.3. Relationship between Child-based Factors (standardized tests) and Performance on Word Learning Tasks

Before examining the relationship between children's lexical abilities and performance on word learning tasks, it was decided to verify whether children had similar, or different, scores on the standardized tests across the three conditions.

Table 10: Performance on measures of semantic and phonological ability across groups (mean and standard deviations given in brackets)

Standardized Assessments	**Visual V**	**Speech S**	**Combined V + S**	**Mean score**	**Sig. (2-tailed)**
Phonological Short-Term Memory [out of 40]	28.25 (3.934)	29.80 (3.882)	30.78 (2.906)	29.48 (3.687)	$F(2, 28) = 1.287$; $p = .292$
Phonological Awareness [out of 21]	15.42 (6.612)	16.90 (5.043)	15.44 (6.064)	15.90 (5.827)	$F(2, 28) = .205$; $p = .816$
Semantic Fluency [number of items correct]	23.42 (4.680)	26.40 (4.742)	25.22 (6.199)	24.90 (5.140)	$F(2, 28) = .939$; $p = .403$
Receptive Vocabulary [BPVS std scores]	86.92 (9.876)	88.60 (8.579)	91.00 (8.139)	88.65 (8.853)	$F(2, 28) = .530$; $p = .594$

There were no significant differences across conditions (see Table 10). In other words, children had similar abilities in each of the three groups. Because only one significant difference was found between conditions in performance on the tasks (section 3.2.), it was decided to combine data across the 3 groups when examining the relationship between children's language abilities and their learning performance.

Table 11: Pearson correlations between standardized tests and measures of word learning

	Picture Naming	**Lexical Decision**	**Comp.**	**Def.**	**Word Knowledge**	**Draw.**
Phonological short-term memory						
Pearson correlations (N = 31)	**.408***	-.104	.289	.067	.270	**.446***
Sig. (2-tailed)	.023	.578	.115	.719	.142	.012
Phonological Awareness						
Pearson correlations (N = 31)	.225	.069	.263	-.045	.208	.165
Sig. (2-tailed)	.224	.712	.153	.811	.263	.376
Semantic Fluency						
Pearson correlations (N = 31)	.184	.042	.200	-.045	.309	**.369***
Sig. (2-tailed)	.322	.822	.280	.809	.091	.041
Vocabulary/BPVS (stdz)						
Pearson correlations (N = 31)	**.457****	.134	**.416***	.275	.268	**.567****
Sig. (2-tailed)	.010	.471	.020	.135	.145	.001

***Correlations significant at the .05 level (2-tailed)**
Comp. = Comprehension; Def. = Definition; Draw. = Drawing

Correlations were calculated between scores on the 4 standardized tests and children's performance on the measures of word learning. A number of significant correlations were identified with r above .35 (see Table 11). Of the two measures of phonological ability, phonological short-term memory (as assessed by the nonword repetition task) appears to be the more important ability in predicting word learning. Indeed, the ability to store information on a temporary basis was positively related to children's ability to name and draw. In relation to the measures involving semantic abilities, the BPVS provided the stronger set of correlations with word learning. Interestingly, there was also a positive relationship between children's ability to make connections between items (semantic fluency) and the accuracy of drawings. However, it should be noted that Bonferroni adjustments (with the number of tests equal to 24) identified the significance level as $p < .002$. As a result, one should exercise caution when interpreting these correlations.

IV. DISCUSSION

This section addresses issues concerning the forms of lexical knowledge accessed when learning new words; the role of semantic and visual information in relation to lexical acquisition and the links between children's characteristics and word learning.

4.1. Access to Lexical Knowledge

Findings confirmed that some forms of lexical knowledge were easier to access than others. Scores on picture naming (mean of 0.65) were significantly worse than all other measures of lexical ability. Performance on the definition task (mean of 1.61) was also poor and significantly worse than on the lexical decision task (mean of 2.29), which is a receptive assessment involving access to phonological representations. The poorer performance on these expressive tasks (picture naming and definition) is consistent with previous work. Moreover, there is also evidence of a distinction between children's naming ability and what

Funnell et al. (2004) described as children's knowledge of words. Specifically, the results showed that children were able to exhibit "knowing" without being able to name (see also Barrow et al., 2000).

Picture naming is typically considered as a complex operation (Goodglass, 1980) involving integration of different types of information, such as knowledge about a word's phonological form, its semantic properties and so on (Johnson et al., 1996; Levelt et al., 1999). As shown by Table 6, children barely managed to name one item, thereby suggesting that the demands of the task were high. For this task, unlike all the other assessments of lexical ability, children were not provided with the phonological form of the word. Instead, they were required to identify the target from a picture and retrieve the appropriate phonological form. As claimed by some researchers (Barsalou, 1999b; Capone & McGregor, 2005), one of the reasons for the inherent difficulty of naming is that fewer cues are available to aid retrieval. However, it also is possible that the difficulties with naming might reflect children's difficulties to access the semantic specification of the novel target words.

Definitions are also believed to be a cognitively demanding task. This metalinguistic task (e.g. Kempler et al., 1998) requires children to consciously access knowledge that is dependent on memory, attentional skills and so on (Shapiro et al., 1998) but also to verbalise this knowledge. The current findings are consistent with Ralli's pyramidal conceptualisation of word learning. Studying the performance of 4-6 year olds on learning tasks, Ralli hypothesized that the acquisition of lexical knowledge was 'graded'. Comprehension would be at the bottom of the pyramid owing to its inherent simplicity (also see Anglin, 1993; Vosniadou et al., 2004). In contrast, naming or the provision of definitions (i.e. expressive abilities) is higher up in the hierarchy as they reflect access to deeper conceptual knowledge. As such, this knowledge is believed to be more difficult to access.

Examining performance on a range of tasks involving lexical abilities also provides insight into the information children acquired. Analyses showed that scores were highest on lexical decision (see Table 6). This suggests that children had a phonological representation of the target words that they were able to match with a stimulus they heard. Thus, it seems that the phonological specification of the word was usually present in memory. According to Demke et al. (2002), in order to produce a word, phonological representations must be strong enough to enable the consistent retrieval and output of the novel word form. Poor performance on the naming task therefore suggests that the difficulty resides either in locating the phonological form of the word or in classifying the stimulus (i.e. access to semantic knowledge).

There are uncertainties about the type of semantic information children acquired during this experiment. Scores on the word knowledge (average of 1.97) and drawing (average of 2.03) tasks suggest that children acquired knowledge about at least one salient perceptual element and/or rudimentary knowledge about conceptual or categorical information. Some have claimed that if the strength of association between a phonological form and conceptual information is not strong enough, word production fails (Capone & McGregor, 2005; Gershkoff-Stowe & Hahn, 2006). The present findings seem to suggest that the integration of semantic and phonological information (i.e. creation of links between conceptual domain and word form) might be the reason for poorer naming scores. Nevertheless, despite the poor performance on the expressive tasks (and picture naming in particular), there is evidence that children reached what Keenan & MacWhinney (1987) have termed a *level of lexical comprehension* (i.e. whereby children can manifest knowledge about the new words).

4.2. Effect of Condition on Word Learning

Before examining the effect of condition on lexical acquisition, it is useful to consider whether learning took place. As illustrated by Table 6, children gained information about several aspects of word knowledge – such as phonological form of the word, its semantic properties and its visual characteristics. Further analysis (Table 7) showed that learning took place and this was not due to chance. Thus, consistent with previous QUIL studies (see work by Rice and colleagues), the current research confirmed that children could acquire different aspects of lexical knowledge in learning contexts where words were not explicitly taught.

Findings indicated there was no main effect of condition on word learning, or in relation to response times. In terns of accuracy, scores were higher (on 5 out of 6 assessments and with one significant difference) when children received the combined set of information (see Table 8). The fact that children had higher scores on the combined condition is consistent with findings from previous work. For instance, Best et al. (2006b) compared the vocabulary gains of 4-6 year olds' across conditions that provided either semantic information (by provision of synonyms) or visual information (by gestures) together with semantic scaffolding. The authors found evidence of learning in both instances. However, vocabulary gains (as assessed by naming, definition and drawing) were higher in the combined condition. This is consistent with the assumption that visual cues can draw attention to the (semantic) properties of target words (Capone & McGregor, 2005), and therefore facilitate the mapping of new words in memory (Funnell et al., 2004; McCormick, 1984).

One of the predictions made was that children in the Speech condition would perform better on the semantic tasks. The findings do not support this prediction as children in the Speech condition had significantly lower scores on both the drawing and the definition tasks. Another prediction was that children in the Speech condition would have difficulty with tasks relying on the visual properties of the target words – i.e. picture naming, drawing and/or comprehension. Interestingly however, there was no significant difference on these tasks between the Visual and Speech conditions and the children in the Speech condition were able to provide a range of responses about the target words, although their performance tended to be worse than children in the Visual condition. In other words, children in the Speech condition were able to make cross-modal inferences. Overall, children's poor performance in the Speech condition tends to suggest that the semantic input was not as effective as visual input. However, these findings ought to be considered with caution. Indeed, the lack of significant differences can be attributed to a number of methodological issues – such as relatively small sample size and limited number of words which provided restricted variance in relation to statistical analyses.

4.3. General Abilities Related to Word Learning

A number of correlations were identified between language abilities assessed by standardised tests and learning measures (see Table 11). Before discussing these it is important to note that one should however use caution in the interpretation of these sets of correlations as the use of Bonferroni adjustments lowers the probability value to .002, in which case most correlations were no longer significant. Of the two measures of phonological ability, phonological short-term memory appeared to be more strongly related to word learning than phonological awareness. The relationship between phonological memory and children's ability to learn novel material is consistent with previous work (Gathercole, 2006; Martin & Gupta, 2004; Michas & Henri, 1994) where researchers have suggested that the temporary storage of unfamiliar phonological forms is essential for building more permanent representations of lexemes in long-term memory.

Moreover, Gathercole and colleagues (1989; 1992; 1999) also found that children who were good at repeating nonwords had larger vocabularies. For example, Gathercole & Baddeley (1989) found that 4 year olds' nonword repetition skills enabled the prediction of receptive vocabulary one year later. Correlations between nonword repetition, vocabulary and word learning have been reported elsewhere. For example, Gathercole et al. (1997) looked at 5 year old children's performance on word learning tasks (with items such as *drattle*, *biffet*, *blaximus* etc) and found a relation between nonword repetition and word learning. More recently, Ellis-Weismer and colleagues (2000) also showed that nonword repetition was an important ability related to language acquisition e.g. in relation to receptive and expressive vocabulary skills and grammatical skills.

In relation to the measures which assessed aspects of semantic knowledge, scores on receptive vocabulary provided the stronger set of correlations (with naming, comprehension and drawing). It is interesting to note that vocabulary was related to drawing rather than definitions. This nevertheless suggests that if more words are known, it might be easier to recall the important physical aspects of the word (McGregor et al. 2002 a & b). This finding is consistent with previous work (Beck et al., 1983) indicating that children's ability to acquire new words was highly dependent on their prior vocabulary (Gathercole et al., 1997; Senechal et al., 1995). Findings revealed that the ability to learn new words was dependent on children's existing vocabulary knowledge but also on the ability to maintain verbal material in memory. In the current research, semantic fluency was also positively correlated with children ability to identify salient visual aspects of targets (drawing). This suggests that knowing which items are grouped together or belong to the same category (notion of semantic relatedness) helps the ability to capture this information through drawings. This is also consistent with suggestions that the richness of the network (lexicon) facilitates the assimilation of novel words.

V. CONCLUSION

The current research on typical children's word learning processes showed that performance on expressive tasks (such as picture naming and definitions) was lower than on tasks involving receptive abilities. There was additional evidence that children could manifest significant vocabulary gains on different aspects of lexical knowledge in contexts where words were not formally taught. However, data analysis showed that there was no main effect of condition on learning performance. This lack of significance could be due to a number of reasons. In particular, it would be useful to have a greater variation in the number of correct responses (both in relation to the sample size and in relation to the number of novel words used). The analyses also indicated that some characteristics of children (in terms of language ability) were related to word learning performance, with vocabulary being the most important factor.

CHAPTER VIII

WORD LEARNING PT.II

I. INTRODUCTION

The current investigation was designed to build on the previous study about typical word learning processes. As mentioned in Chapter VII, limitations were identified in the methodology employed in the study, and these could have been responsible for the lack of significant differences between conditions. As a result, it was decided to use a larger sample of children. It was also decided to increase the number of target words so as to have a larger spread of scores from each child, and thus have a greater variation in the number of correct responses. Given the findings from Chapter VII and the need to minimise the length of the session, it was decided not to include any standardised assessments.

The three research questions addressed in this chapter develop the issues dealt with in Chapter VII. The first issue concerns the forms of lexical knowledge acquired in a world learning task. The second issue concerns whether learning took place in a learning context where novel nonsense words were not formally taught. The final issue concerns how the nature of the input (semantic vs. visual) influenced the process of lexical acquisition and the types of representations subsequently formed. These issues will be briefly outlined below, but see previous chapter for more detail.

Knowledge about a word is graded and varies along a continuum from minimal knowledge (e.g. knowing what the words sound like) to more extensive information (e.g. being able to define what words mean, what category they belong to, what other type of object are they similar to etc.) about different aspects of the words (Beck et al., 1991; Miller, 1999; see

Chapter VI). Therefore, comparing children's performance on these different measures of lexical knowledge will provide insight as to what kind of information children have acquired about each of the target words. This in turn, might provide indications as to the types of lexical representations (semantic, visual or phonological) that are formed in a word learning context.

Furthermore, according to Funnell et al. (2004), a distinction can be made between children's ability to name novel words and their ability to *know* about these words (see also Barrow et al., 2000). Funnell et al. claim that naming and knowing follow different developmental patterns, where younger children would be better at naming and older children better at knowing about words. However, investigations of word learning have rarely used measures tapping into both these abilities together.

For all these reasons, in the current investigation, it was decided to present children with 5 nonsense words. Knowledge of these words was assessed on a number of dimensions to determine how complete children's initial representations of newly acquired words were. The assessments used involved different levels of difficulty – such as children's ability to provide accurate information about the semantic properties of the words or identify their phonological sound forms as well as the physical characteristics of the referent.

A second issue was to determine whether there was a significant increase in children's knowledge about each particular item. Previous studies that have use the story-presentation format (i.e. QUIL paradigm – see work of Rice and colleagues) have shown that children can learn after several exposures to novel words in an illustrated story context (Rice et al., 1990a & b & c; Rice et al., 1994; Oetting et al., 1995). In these studies, evidence of word learning or so-called vocabulary gains was provided by comprehension tests requiring children to 'recognise' the adequate target among a set of pictures ("*Show me X?*"). Seldom have children been asked to produce the novel verbal label (see Table 1 in Chapter VI). By using a greater range of tasks (see Chapter VI), it was possible to assess what type of knowledge children acquired and whether there were significant increases compared to what might be expected by chance.

A final issue that was addressed concerned two inter-related topics. One of these involved identifying which of the input conditions (visual vs. speech vs. combined) were the most effective in terms of word learning on the range of assessments that were employed. Previous studies of word learning (see Table 1; Chapter VI) have typically presented children with the visual referent to see if children could learn the name of the object. However, the aim of the current study (see also Chapter VI) was to expand the scope of the research into typical word learning processes by examining the effects of input conditions where there was visual input but no supplementary semantic information, or no visual input and supplementary semantic information, or a combination of both visual and semantic information. As several authors have claimed, the nature of the word learning experience is believed to determine the types of lexical representations that are ultimately formed (see Funnell et al., 2004; Rice et al., 2000). One might anticipate that children receiving the combined input will perform better than the two other groups as they received a more detailed set of information.

A second related topic concerned how different types of input impact on children's performance across different types of tasks. Of particular interest was the issue of whether children are able to draw information from one type of input modality (i.e. either a semantic or visual input) and transform this information so that more general lexical knowledge about other dimensions are acquired. Specifically, one might anticipate the provision of visual information (i.e. where children are shown pictures) to facilitate performance on tasks that involve this visual element – such as drawing the target, recognising its physical characteristics among sets of distracters, but this might not help with tasks involving, for example, definitions. One might also expect these children to be faster at the former tasks. Similarly, it is anticipated that the provision of semantic information (i.e. where children are explicitly given information about the type of object) would help performance in tasks which tap into aspects of word meaning (e.g. definitions), but not necessarily tasks that involve pictorial representations (e.g. drawing).

II. METHODOLOGY

2.1. Participants

Data was collected from 67 children from three different classes (see Table 1 below) in a mainstream school (with single-sex female students) in the Bedfordshire area. Unlike the previous study, this school was in a relatively affluent catchment area. The sample was from middle to upper socioeconomic class homes (as determined by the catchment area of the school).

2.2. Design

A between subjects design was used. Children, from each year group, were randomly assigned to one of three experimental conditions. All children heard a story containing the same 5 novel words (celtar – klower - genum – inlect – girter). Prior knowledge was thus controlled by the use of nonsense words. In the Visual condition children saw pictorial information to accompany the narrative. In the Speech condition, children were provided with explicit information about word meanings (i.e. type of object, categorical information, location etc.), though no pictures were used. A Combined condition presented children with both a picture of the referent, as well as semantic information. As far as possible, an attempt was made to match the content of the pictures with the semantic information provided orally.

Table 1: Characteristic of children across the three age groups

	Year 4 (8-9 year olds)	Year 5 (9-10 year olds)	Year 6 (10-11 year olds)
Age (in months)	M = 106.57; SD = 4.80	M = 117.23; SD = 6.53	M = 129.36; SD = 3.34
Number of children	23	22	22

2.3. Apparatus and Procedure

2.3.1. Materials – The Stories used in the 3 Conditions

All children heard a story about Sammy the rabbit who went on a trip around the world and talked about 5 fantasy objects, the story was an adaptation of the one described in Chapter VI. The stories were heard via computer and headphones. SuperLab Pro for Windows (Cedrus & Chase, 1990) was used to construct the tasks.

Children heard stories about each of these referents (presented in the same fixed order; see Appendices J and K for script of stories and K pictures seen). Nonsense words were taken from Masterson (1989) and consisted in a *celtar* (representing a novel type of tree), *klower* (representing a novel musical instrument), *genum* (representing a novel type of animal), *inlect* (representing a novel type of house), and *girter* (representing a novel type of vehicle). The number of exposures was kept constant – with 8 repetitions of each novel word. Stories ran for approximately 10 minutes. Each child was allocated randomly to one of three conditions (see Chapter VI - section 2.3.1. for description of the conditions).

Table 2: Distribution of children in the three experimental groups

Experimental group	Number of children in each condition	Age (in months)
Year 4	Visual (n = 8) Speech (n = 8) Combined (n = 7)	M = 106.75; SD = 5.67 M = 105.13; SD = 5.08 M = 108.00; SD = 3.41
Year 5	Visual (n = 8) Speech (n = 7) Combined (n = 7)	M = 117.63; SD = 6.02 M = 117.00; SD = 6.88 M = 117.00; SD = 7.70
Year 6	Visual (n = 8) Speech (n = 7) Combined (n = 7)	M = 128.75; SD = 2.37 M = 130.86; SD = 3.80 M = 128.57; SD = 3.78

2.3.2. Word Learning Assessments

Children were assessed on the following tasks: picture naming, lexical decision, definition, drawing and forced-comprehension. These tasks were administered in the same fixed order for all children (see below). The order of the tasks was chosen so as to minimise any carry over effects. The two tasks where children were given minimal information about the target words were presented first (i.e. picture naming and lexical decision). The definition and drawing tasks which required children to provide more detailed information followed. Finally, the forced comprehension task, which required children to correctly identify the relevant target picture upon being given its name, was presented last.

This section provides a description of the materials, instructions and data recording procedure.

2.3.2.1. Picture Naming

A discrete picture naming task was used to examine whether children had sufficient knowledge about a word in order to retrieve and subsequently produce the word form.

Apparatus: 15 coloured pictures were used: 5 drawings of the target referents (*celtar*, *klower*, *genum*, *inlect* and *girter*), 5 pictures representing real objects from the same category (tree, musical instrument, animal, house, vehicle); 5 distracters representing modified pictures of the targets (i.e. *celtar* without the branches, *klower* without the ring around it, *genum* without fangs, *inlect* with a different shaped roof, *girter* without the springs). Pictures were scanned and integrated into the computer program. The task was set up using the SuperLab-Pro software for Windows (Cedrus & Chase, 1990).

Procedure: Pictures appeared randomly, one at a time, in a central position on the screen and remained until they were named. Children were required to name them as quickly as possible but without sacrificing accuracy: "*You will see pictures on the screen, one at a time. Tell me the name of the picture as quickly as you can, but without making mistakes. If you don't think there is a name for the picture, just say "No name"*. The experimenter pressed a key according to the accuracy of response (key "a" for error, "q" for correct and "z" for "no name"). The start and end of each session was signalled both visually (display on-screen) and verbally (by the experimenter). **Data recording:** Accuracy of response ranged from 0 (no target correctly named) to 5 (all targets correctly named). For a response to be coded as correct, children had to pronounce the word at it was initially presented (i.e. 100% accurate). Speed of response was recorded in milliseconds by the software and started from the moment a picture appeared on the screen to the onset of a child's response.

2.3.2.2. Lexical Decision

This task was used to examine children's phonological recognition of the novel words, when competing distractors were present. **Apparatus**: Fifteen words were used: 5 target names (*celtar*, *klower*, *genum*, *inlecti* and *girter*); 5 names of real objects from the same category (tree, trumpet, dog, house and car) and 5 distracters with modification of the final sound of the target words (*celtium*, *kloneg*, *gesail*, *intobe* and *girdon*). These modifications followed the technique used by Gaskell & Dumay (2003), who claimed that modifications of the final segment of distracter words ensure the presence of lexical competition between the target words and the nonsense words. According to these authors (also see Gaskell, 2006), the strongest evidence that a novel phonological sequence has been acquired (or "lexicalised") is when children can discriminate between a target word and these lexical competitors (p. 107). This task was set up using SuperLab-Pro (Cedrus & Chase, 1990).

Procedure: The words were presented randomly for each child via headphones. Children were instructed as follows: "*You are going to hear some words, one at a time. Some of the words are the names of the items that Sammy saw on his trip around the world. Tell me if you have heard this word before in Sammy's story: are these names of the objects that Sammy saw?" Say "YES" if it is an object that Sammy saw; say "NO" if it is not an object that Sammy saw. Try to be as quick as you can, but without making mistakes.*" Children's responses were recorded by the experimenter pressing colour-coded keys: "q" if children said "yes" and "a" for "no". The start and end of each session was signaled both visually and verbally.

Data recording: Accuracy of response ranged from 0 (no target correctly named) to 5 (all targets correctly named). Speed of response was recorded in milliseconds by the software and started from the moment a word was heard to the onset of a child's response.

2.3.2.3. Definition

Apparatus & Procedure: Children were asked to define the 5 target words. These were presented in a random order as follows: "*Tell me what this word means. Tell me everything* *you know about it. Try to be as quick as you can. Are you ready?"* **Data recording:** Accuracy was the number of correct elements of responses (see coding grid in Table 3 below). Multiple coding was allowed in order to capture the range of children's responses. The duration of a child's response was recorded via a stopwatch from the moment the child started to speak u4ntil the end of their response.

Table 3: Coding grid for verbal definition task

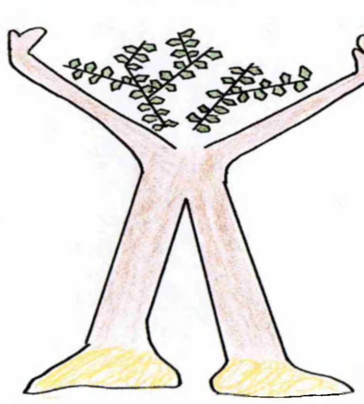
CATEGORIES	DEFINITION
Perceptual	Types of responses describing the target's descriptive characteristics, features or working parts. For example: "*It has sharp teeth*" (for the animal); "*It is shaped like a football*" (for the instrument); "*It is a rounded house[...]*" (for the house).
Semantic category membership	Types of responses that provide information about the type of relationship with the target word. These can consist of superordinate (e.g. "*It's a house*", "*It's a tree*" etc.) or coordinate (e.g. "*It's a type of dog*"; *It's a sort of instrument*") levels of association.
Association or analogies	Types of responses that are based on similarities between the target word and a child's response. For example: "*It looks like a Y*" (for the tree); "*It looks like a toadstool*" (for the house; "*It looks like a funny planet*" (for the instrument).
Functional	Types of responses that provide information about the possible uses one can make of the item, or what the item can do. For example: "*You can sit on it*" (for the tree); "*You can sleep in it*" (for the house); "*You can eat it*" (for the animal); "*People travel in it to get to places*" (for the car).
Location	Types of responses that provide information as to where one can find the target items. For example: "*It lives in a zoo*" or "*It lives behind bars*" (for the animal); "*It is in the countryside*" (for the tree).
Acceptable Inference	Types of responses that include plausible extrapolations or inferred answers consistent with the storyline. For example "*The genum* (animal) *is friendly when you give it food*"; "*You can find it in neverland*". This information is not specified in the storyline but is consistent with the nature of the animal/characteristic of the target, as described in the story.
Other	Types of responses that consist of either "*Don't know*" responses, wrong identifications of a target (saying it is a tree when defining the animal), irrelevant or incoherent responses (e.g. "*It is a girl*" when defining the car).

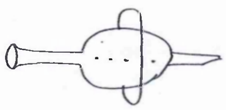
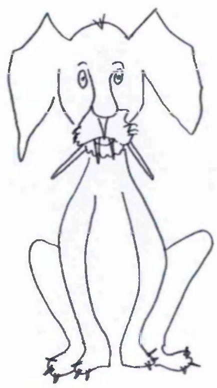
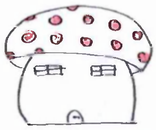
2.3.2.4. Drawing

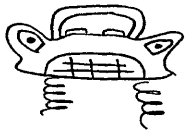
Apparatus & Procedure: Children were provided with a pencil and sheets of paper, and instructed as follows: "W*e are going to play another game. I am going to ask you to draw some objects for me. Don't take too much time as I will be timing you, but try to be as accurate as possible. Are you ready? Go!*"

Data recording: Accuracy was assessed by use of a coding grid which awarded +1 point for each salient perceptual characteristic that children included in their drawings. Thus, children could score a total of 25 points [5 points per target]. The total time taken to complete a drawing was recorded via a stopwatch (in milliseconds) – starting from the moment a child put pen to paper and started to draw.

Table 4: Coding grid used for the drawing task

TARGET(S) & TOTAL NUMBER OF POINTS	DRAWING & ALLOCATION OF POINTS
TREE [5 points] 	• 2 trunks apart --- +1 • Letter A shape (part of storyline) --- +1 • Shoes at bottom --- +1 • Leaves --- +1 • 2 branches apart --- +1

MUSICAL INSTRUMENT [5 points] 	• Round sphere --- +1 • Ring around it --- +1 • 5 tiny holes --- +1 • One end trumpet-like --- +1 • Other end (mouthpiece) narrower --- +1
ANIMAL [5 points] 	• 2 ears --- +1 • 2 fangs --- +1 • 2 elephant tusks --- +1 • Facial features (eyes, nose, whiskers, shape of face) --- 0.25 x 4 • Additional features present in other pictures seen in the story: general outline of body, legs, claws, tail --- 0.25 x 4
HOUSE [5 points] 	• Roof and red spots --- +1 • Shape of building (large at bottom, slightly narrower on top) --- +1 • Door and windows --- +1 • Platform --- +1 • Additional features (seen/heard in story): ladder, wheels, someone pulling with ropes, legs of platform --- 0.25 x 4

VEHICLE [5 points] 	• General shape of car --- +1 • Springs --- +1 • Headlights --- +1 • Shape of headlights like frogs eyes --- +1 • Additional features (part of storyline): wheel, map, lever, lights --- 0.25 x 4

Scorer reliability: All drawings (5x67) were coded immediately after the testing session. In order to establish coder reliability, 10% of all the drawings (i.e. approximately 30) were chosen at random and re-coded 2 years later. Eighty-percent of the pictures were scored within 1 point of one another. Correlations were carried out between initial scores and the new coding and showed that there was agreement between both sets of scores ($r = .663$; $p < .001$).

2.3.2.5. Forced-choice comprehension

Apparatus: A set of 10 pictures was presented on a laminated A4 card (5 target pictures encountered in the storyline and the 5 distracters which consisted of slight modifications to the target pictures, i.e. by excluding one or two salient features. Children were instructed as follows: "Now, *I will say a word. Look carefully at all the pictures and point to the picture that matches the word/is the thing in the picture. Which is the best match? Try to be as quick as you can. Are you ready? Where is the "X"* (start stopwatch). The experimenter signalled the start and end of each session verbally.

Data recording: Accuracy of response consisted in awarding +1point for each correct identification (maximum out of 5). Latency of children's responses was recorded via a stopwatch (in milliseconds). The timing began at the end of the instruction.

2.3.3. Procedure

Children were seen individually, in a quiet room on the school premises. Children were sent to the experimenter by the class teacher, who chose children of mixed ability. Each session lasted approximately 25 minutes.

III. RESULTS

Three issues were addressed: whether there were differences in performance across tasks tapping into semantic, visual or phonological knowledge; whether children performed better than one would expect by chance; and whether the nature of the input (i.e. semantic vs. visual) impacted on the type of information (or types of representations) that were subsequently formed. As in Chapter VII, analysis of response times to correct answers involved the whole data set (including outliers). Non-parametric statistics were used to analyse response times (for rationale see Chapter VI – section 2.3.4.).

3.1. Access to Different Types of Lexical Knowledge

The picture naming, comprehension and lexical decision tasks were scored out of 5 (i.e. corresponding to the number of correct target items identified), but the definition and drawing tasks could receive scores greater than 5 – as several answers could be given about each target. Because of this, it was decided to create an additional variable for the definition and drawing tasks in which 1 point was awarded for any correct response a child provided about an item (so as to have a maximum of 5 correct responses for definitions and drawings). This variable was used for data analysis in this and in the next section.

Table 5: Performance across tasks for the whole sample (from lowest to highest scores)

	Mean [total out of 5]	Standard Deviation
Picture Naming	1.31	1.258
Definition (out of 5)	2.87	1.604
Comprehension	3.37	1.650
Drawing (out of 5)	3.87	1.313
Lexical Decision	4.18	.984
Definition (raw score)	12.78	6.229
Drawing (raw score)	13.49	10.283

An analysis was carried out to determine whether there were significant differences in the difficulty of the tasks. The MANOVA showed the presence of a main effect of task with $F(4, 264) = 81.145$; $p < .001$; $\eta p^2 = .551$ (signifying a large effect). Main effects were compared by using Bonferroni's confidence interval adjustment. Findings revealed that (a) scores on the discrete picture naming task were significantly lower than scores on all other measures of lexical ability ($p < .001$); (b) scores on the definition task were higher than picture naming ($p < .001$), but lower than the other measures of lexical ability (p varying between .000 and .024); (c) scores on the comprehension task were significantly lower than scores on the drawing ($p = .016$) and lexical decision ($p = .002$); (d) there was no significant difference between performance on the drawing and lexical decision tasks ($p = .410$).

3.2. Did Learning Occur?

A one-sample t-test was used to investigate whether children made significant gains in terms of learning for each of the 3 conditions under consideration. Analyses revealed that scores, for all the tasks and for each condition, were significantly greater than expected at $p < .001$, thereby indicating that children were able to gain information irrespective of condition or the type of input they received (see Table 6 below). Also, all the effects observed were considered to be large (from Cohen, 1988). For the naming, definition and drawing tasks the expected value was set at zero as it would be impossible to produce the correct answer by guessing. However, in the case of the comprehension and lexical decision tasks children could, by chance, produce the correct answer by guessing (10 alternatives were given for the comprehension task and 2 alternatives were presented for each of the lexical decision task). In order to check whether children's performance was better than would be expected by chance, the appropriate probabilities were entered as the expected value (i.e. .10 for the comprehension test and .50 for the lexical decision task) in the on sample t-test. In both cases, the actual value significantly exceeded the expected one.

Table 6: Output for the one-sample t-test on all measures of lexical ability

VISUAL CONDITION	Mean (SD) [max out of 5]	T-value	Cohen's D* Effect Size
Picture Naming	1.79 (1.351)	$t(23) = 6.499$; $p < .001$	$d = 0.97$
Definition	3.13 (1.650)	$t(23) = 9.278$; $p < .001$	$d = 1.46$
Comprehension	3.71 (1.429)	$t(23) = 12.371$; $p < .001$	$d = 2.52$
Drawing	4.42 (.717)	$t(23) = 30.166$; $p < .001$	$d = 2.31$
Lexical Decision	4.42 (.929)	$t(23) = 20.663$; $p < .001$	$d = 4.21$

SPEECH CONDITION	Mean (SD) [max out of 5]	T-value	Cohen's D* Effect Size
Picture Naming	.86 (.88)	$t(21) = 4.557$; $p < .001$	$d = 0.97$
Definition	2.05 (1.397)	$t(21) = 6.870$; $p < .001$	$d = 1.46$
Comprehension	2.18 (1.468)	$t(21) = 6.650$; $p < .001$	$d = 1.41$
Drawing	3.14 (1.356)	$t(21) = 10.852$; $p < .001$	$d = 2.31$
Lexical Decision	4.00 (1.195)	$t(21) = 13.735$; $p < .001$	$d = 2.92$

COMBINED CONDITION	Mean (SD) [max out of 5]	T-value	Cohen's D* Effect Size
Picture Naming	1.24 (1.338)	$t(20) = 4.240$; $p < .001$	$d = 0.92$
Definition	3.43 (1.469)	$t(20) = 10.698$; $p < .001$	$d = 2.33$
Comprehension	4.24 (1.375)	$t(20) = 13.792$; $p < .001$	$d = 3.00$
Drawing	4.00 (1.483)	$t(20) = 12.358$; $p < .001$	$d = 2.69$
Lexical Decision	4.10 (.768)	$t(20) = 21.441$; $p < .001$	$d = 4.68$

*** Cohen's Effect Size calculated as follows: d = (mean difference / SD)**
D effects: 0.2 to 0.5 = small effect; 0.5 to 0.8 = medium effect; > 0.8 = large effect (from Cohen, 1988)

To further investigate whether the children were providing more correct answers to the lexical decision task than would be expected by chance a calculation was made of the total number of correct answers to items which corresponded to the target word (i.e. should be answered 'yes', e.g. "celtar") and the items which were created to be similar but not the same as the target words (i.e. should be answered 'no', e.g. "celtium"). A comparison using a related t-test showed a significant difference between the frequency with which children correctly identified the new words they heard (e.g. 'celtar') and the frequency with which they incorrectly responded that the non-target word they heard (e.g. celtium) was one of the target words – [$t\ (66) = -20.181$; $p < .001$]. This shows that the new word forms had been learnt. If the children had answered randomly, one would expect no significant difference between these two sets of scores.

3.3. Effect of Condition on Word Learning Performance

This section contains an examination of the effect of condition on children's accuracy scores on the 5 assessments of lexical knowledge. Data will also be examined in relation to children's timed performance on these 5 tasks, separate analyses were conducted of the latency of responses for online tasks (i.e. picture naming, comprehension and lexical decision) and duration of response for semantic offline tasks (i.e. definition and drawings)

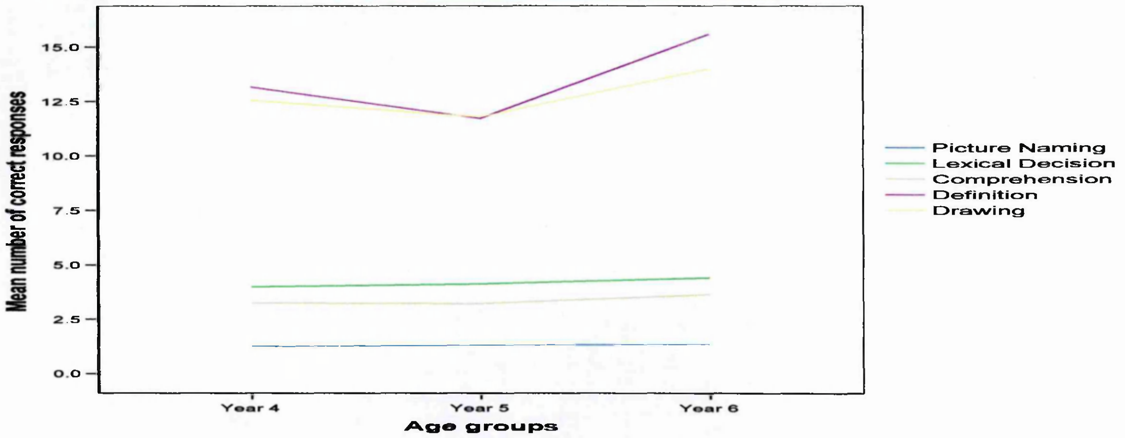
3.3.1. Accuracy of Responses

In order to capture the full range of children's performance, it was decided to conduct the analyses with the total number of correct elements of responses for both the definition and the drawing task. Figure 1 provides information about the accuracy of children's responses according to age and condition. As can be seen, the Year 5 children appeared to be worse on the definition and drawing tasks compared to the two other age groups and children in the

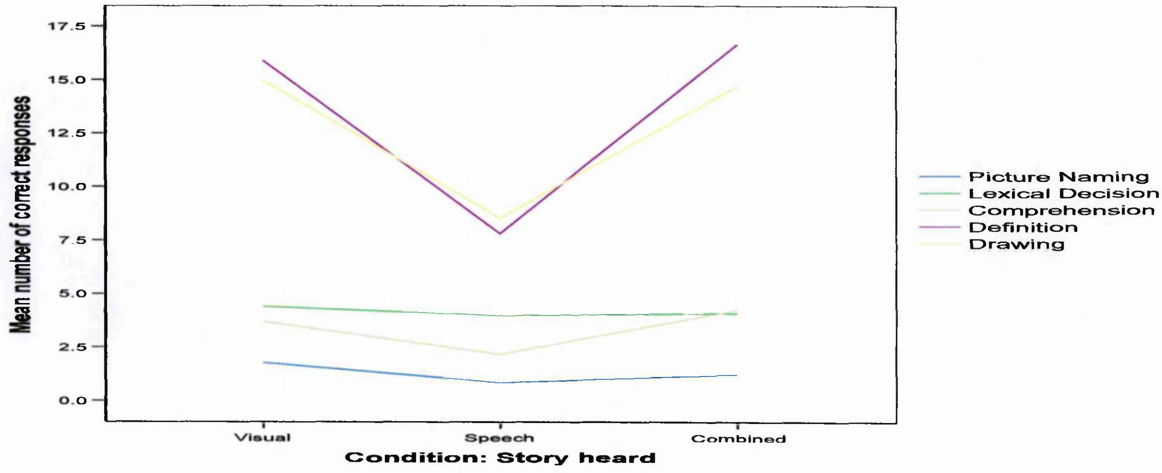
Speech condition were the least accurate of the three groups on the two offline tasks (i.e. drawing and definition) and on comprehension and picture naming.

Figure 1: Accuracy of response according to Age and Condition

(A) ACCURACY OF RESPONSE
ACROSS AGE



(B) ACCURACY OF RESPONSE
ACROSS CONDITION



Two-way ANOVAs were conducted in relation to age (Year 4, Year 5 and Year 6 children) and condition (Visual, Speech and Combined) with the dependent variables, for each analysis, being children's performance on picture naming, lexical decision, comprehension, definition and drawing tasks. Tukey and Bonferroni post-hoc tests were to identify the differences (when applicable) between conditions. Finally, Eta squared values, representing the effect size of the effect observed, are also presented (when appropriate) in the table. Table 7 summarizes the main findings.

Table 7: Summary table from the output of the analysis on accuracy

Source of Variance	Sum of Squares	Degree of Freedom	Mean Square	Sig. (2-tailed)	Partial Eta Square (Effect size)
Picture Naming					
Main effect of Age	.095	2	.048	.970	
Main effect of Condition	10.289	2	5.145	.044*	($\eta p^2 = .102$= large)
Interaction: Age x Condition	3.603	4	.901	.681	
Lexical Decision					
Main effect of Age	1.913	2	.957	.397	
Main effect of Condition	2.205	2	1.103	.345	
Interaction: Age x Condition	.729	4	.182	.948	
Comprehension					
Main effect of Age	1.787	2	.894	.650	
Main effect of Condition	50.303	2	25.151	$p < .001$	($\eta p^2 = .296$= large)
Interaction: Age x Condition	8.613	4	2.153	.391	
Definition(*)					
Main effect of Age	150.196	2	75.098	.428	
Main effect of Condition	1090.210	2	545.105	.003**	($\eta p^2 = .178$= large)
Interaction: Age x Condition	701.628	4	175.407	.104	
Drawing(*)					
Main effect of Age	49.646	2	24.823	.461	
Main effect of Condition	598.416	2	299.208	$p < .001$	($\eta p^2 = .246$= large)
Interaction: Age x Condition	140.797	4	35.199	.359	

*** Total is variable and corresponds to the total number of correct items children provided**
$\eta p^2 < 0.01$ = small effect; ηp^2 between 0.01 and 0.10 = medium effect; $\eta p^2 > 0.10$ (from Clark-carter, 1997)

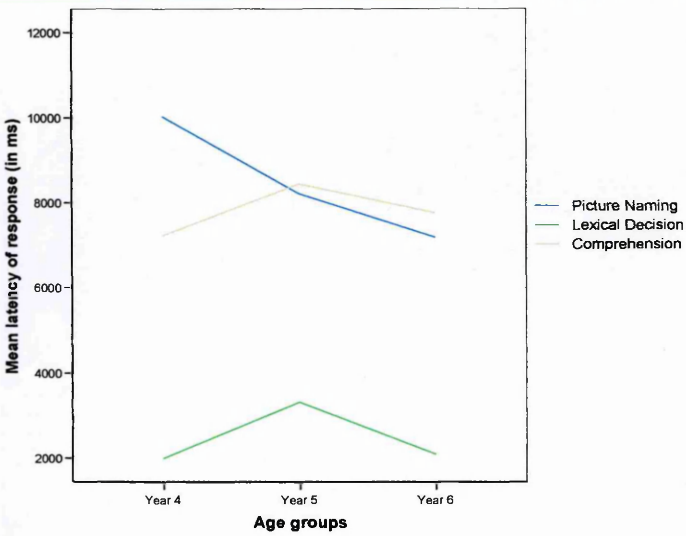
There was no effect of age across tasks (see Figure 1.A and Table 7). However, data analysis revealed a main effect of condition on 4 out of the 5 tasks (only performance on the lexical decision task did not differ across conditions; see Figure 1.B), with children in the speech condition performing significantly worse than the other groups of children. Indeed, in relation to the online measures of ability: (a) on picture naming, children in the Speech condition were significantly less accurate than children in the Visual condition ($p = .041$); (b) children in the Speech condition also obtained significantly lower scores on comprehension compared to the Visual ($p = .002$) and to the Combined ($p < .001$) groups. In relation to the offline tasks (i.e. definition and drawing): children in the Speech condition provided significantly fewer correct responses than children in the Visual ($p = .012$ and $p = .001$ respectively) and Combined ($p = .008$ and $p = .002$ respectively) conditions.

3.3.2. Latency and Duration of Responses

Figure 2 shows the latency and duration of children's responses first according to age, and then according to condition. Two observations are worth making. First, The Year 5 children tended to have longer latencies on the lexical decision and comprehension tasks, but to take less time to provide definitions or to do drawings (i.e. offline tasks). Second, children in the Speech condition appear to have responded more quickly than the other groups on the picture naming and lexical decision tasks but not on the comprehension task.

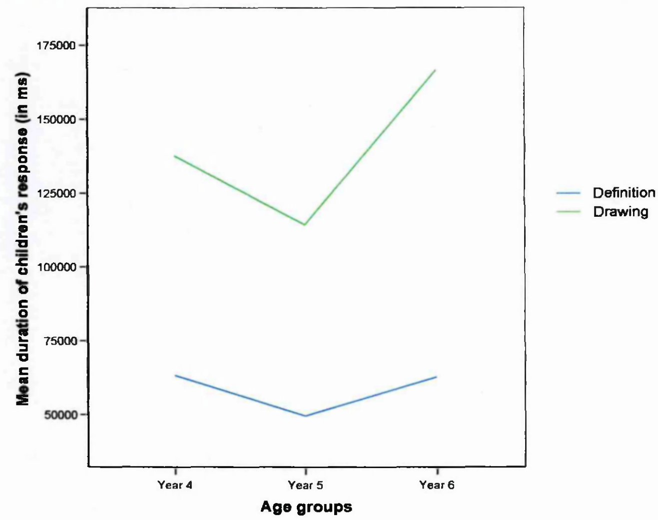
Figure 2: Children's timed performance according to Age and Condition

LATENCY OF RESPONSE
ON ONLINE TASKS ACCROSS AGE



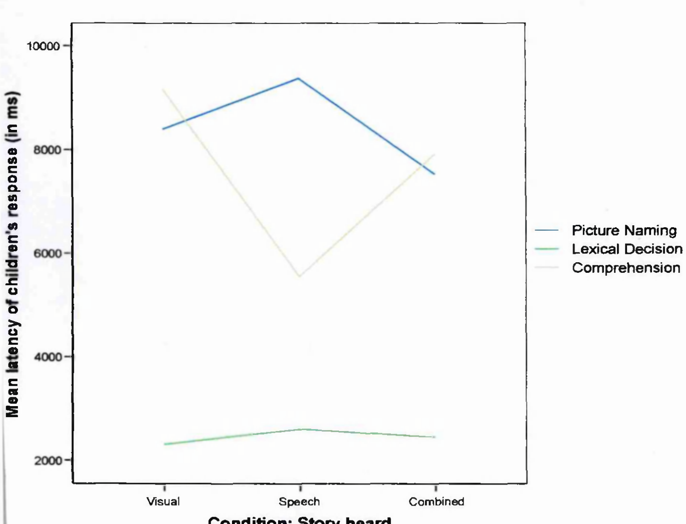
----- Picture Naming
----- Lexical Decision
----- Comprehension

DURATION OF RESPONSE
ON OFFLINE TASKS ACROSS AGE



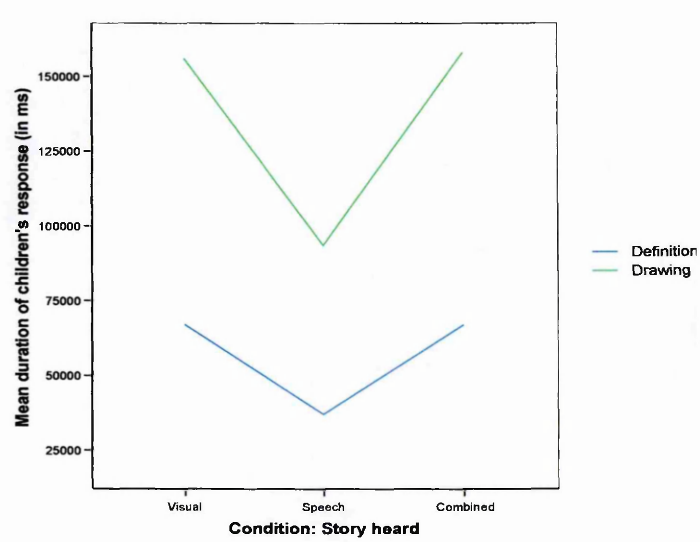
----- Drawing
----- Definition

LATENCY OF RESPONSE
ON ONLINE TASKS ACROSS CONDITION



----- Picture Naming
----- Lexical Decision
----- Comprehension

DURATION OF RESPONSE
ON OFFLINE TASKS ACROSS CONDITION



----- Drawing
----- Definition

Further inferential analyses were conducted on these data, using non-parametric analyses. A Kruskal-Wallis test was used to detect the presence of significant differences between response times of the three groups of children on the five measures of lexical ability – i.e. picture naming, lexical decision, comprehension, definition and drawing. There was a main effect of Condition on the comprehension, definition and drawing tasks (see Table 8). A Mann-Whitney 2-samples independent test was used to specify where the differences occurred. These indicated that children in the Speech condition were significantly faster to 'recognize' the target picture on the comprehension task (M = 5131; SD = 3509), they also took significantly less time to provide definitions of the novel target items (M = 35723; SD = 29648) and to draw them (M = 88127; SD = 61994). A similar analysis using the Kruskal =-Wallis test revealed there were no significant effects of age (see Table 8).

Table 8: Summary table of analyses on children's timed performance across tasks

Source of Variance	**Sig. (2-tailed)**	**Mann-Whitney (U) [Post-hoc]**	
Picture Naming			
Effect of Age	$X^2(2) = 1.183; p = .553$		
Effect of Condition	$X^2(2) = .074; p = .964$		
Lexical Decision			
Effect of Age	$X^2(2) = 1.733; p = .420$		
Effect of Condition	$X^2(2) = .179; p = .914$		
Comprehension			
Effect of Age	$X^2(2) = .188; p = .910$		
Effect of Condition	$X^2(2) = 6.123; p = .047$*	Visual-Speech	U = 144; exact p = .036* (2-tailed)
		Visual-Combined	U = 221; exact p = .833 (2-tailed)
		Speech-Combined	U = 119; exact p = .028* (2-tailed)
Definition(*)			
Effect of Age	$X^2(2) = 1.504; p = .471$		
Effect of Condition	$X^2(2) = 7.450; p = .024$*	Visual-Speech	U = 126; exact p = .019* (2-tailed)
		Visual-Combined	U = 230; exact p = .798 (2-tailed)
		Speech-Combined	U = 110; exact p = .015* (2-tailed)
Drawing(*)			
Effect of Age	$X^2(2) = 2.837; p = .242$		
Effect of Condition	$X^2(2) = 15.158; p = .001$**	Visual-Speech	U = 91; exact p < .001 (2-tailed)
		Visual-Combined	U = 209; exact p = .476 (2-tailed)
		Speech-Combined	U = 82; exact p = .001** (2-tailed)

*** Total is variable and corresponds to the total number of correct items children provided**

IV. DISCUSSION

The discussion focuses on two issues (i) the children's access to lexical knowledge about the target items, (ii) whether the type of input influenced performance on particular tasks.

4.1. Access to Lexical Knowledge

The children's performance across several measures of lexical knowledge provided data about the types of representations that were available, or formed, after exposure to the novel target items. The first point to make is that children across all three conditions showed significant gains on all the tasks. These findings corroborate the conclusions formed, for instance, by Rice and colleagues (e.g. Rice 1995; Rice et al., 2000) where children are able to form lexical representations of novel target words after several exposures in a word learning paradigm.

As illustrated by Table 1 in Chapter VI, previous research has often involved assessments of word learning by using comprehension tests. Findings from the current research corroborate this work by showing reasonably high levels of performance on the comprehension tests. However, although the current research showed that learning occurred (as illustrated by the presence of significant gains on all tasks), there was nevertheless evidence that learning was not complete. Indeed, going back to the distinction made by Funnell and colleagues (2004), it seems that children, overall, *know* about the novel words though they often cannot *name* them. This is what Nelson (1996) labeled as the *identity level,* whereby children were able to express knowledge (or the phenomenon of "knowing") but without being able to name the relevant item. Although children's performance on naming might appear poor in the current study (compared with previous findings from Rice and colleagues for example), several reasons could explain this discrepancy. Unlike previous work (see Table 1 in Chapter VI), children in the current study were presented with nonsense words (which might have been more difficult to acquire), many previous studies have also used a limited number of target words whereas 5 words were used in the current research; and finally, children were typically assessed immediately after presentation of the novel words whereas in the current study there was a delay (because of the duration of stories as all words were presented first before testing and so on).

The findings also showed that certain types of representations were better specified, or easier to access, than others. On the lexical decision task children were able to distinguish 4 of the 5 target words from other phonological forms and their scores on this task were significantly higher than on all the other tasks except drawing. This suggests that phonological information was the easiest form of information to acquire and to use – although this might be explained by the repeated exposures to the same stimuli. It should be noted that in this task children could, by guessing, have achieved a correct response on 50% of the occasions, analysis of the scores for correct responses to the target words and for incorrect but similar sounding nonsense words showed that the majority of answers were appropriate and that this was significantly higher than would be expected by chance.

Children also were able to produce drawings relevant to the visual characteristics of nearly 4 of the 5 target items. The relatively high scores on the drawing task show that children have developed some form of representation and have acquired at least some visual representation of most of the target items. However, one needs to note that the scores on the drawing task may have been inflated relative to other tasks, because only one visual characteristic needed to be identified when scoring knowledge about the targets. It is possible that the visual representations were associated with some categorical knowledge, although data from the drawing task alone is not sufficient to determine the extent of semantic or conceptual information a child possesses. Indeed, although this task is believed to capture aspects of semantic and visual knowledge, McGregor et al. (2002) claim that drawings primarily capture the physical properties of the target – rather than conceptual information (but see Best et al., 2006a).

The comprehension task involved identifying the appropriate visual representations of the target item, after being given the name of an item. Children had significantly lower performance on the comprehension task than the drawing task, but even with on the comprehension task they were able to identify on average 3 of the 5 target items and this score was not very different in size from that in the drawing task (3.87 vs. 3.37). The fact that the children's scores on the comprehension task were significantly lower than the drawing task suggests that although they were able to produce relevant aspects of the target item when drawing, their visual representation of the target items was not always sufficiently complex to distinguish between the target and related pictures. It also is of interest that there was a significant difference between the lexical decision task and the comprehension task, tasks which bear similar demands but involve different modalities (although it should be noted there was a greater choice in the comprehension task which may have made the task more difficult), which reinforces the suggestion that phonological representations are easier to acquire and utilise than visual representations. This might be explained by the fact these tasks tap into different levels of difficulties and that visual representations are both more complex and variable in nature.

The children's performance on the definitions task, where they had to identify at least one semantic attribute of the target, was significantly worse than all the other tasks that have been discussed so far. The fact that performance on this task was significantly worse than on the drawing task suggests that visual representations are easier to acquire and access than semantic representations. However, it also should be noted that the total number of visual characteristics and total number of semantic aspects that were identified were very similar (see Figure 1). The task with the worst performance of all was the naming task. As already discussed (see Chapter I for example), picture naming involves integrating different forms of lexical knowledge during the process of categorising a visual target and then identifying the appropriate phonological form. Thus, it would appear that even though the children were building up knowledge of different aspects of the target words, they had difficulty integrating all this knowledge when they had to identify and access the phonological form from a visual exemplar.

The overall difference in levels of performance across the 5 tasks is probably the result of several influences on word acquisition and production. As discussed in the previous chapter, tasks involving production usually are more difficult than tasks involving comprehension (Barsalou, 1999b; Donaldson & Laing, 1993; Ralli, 1999). This distinction can account for the poorer performance on picture naming and definitions task, so that the children may have had no or incomplete semantic specification of the target items (see Table 5). For example, research by McGregor and colleagues has indicated that accurate naming was indicative of children having acquired semantic knowledge (McGregor et al., 2002a). In the case of definitions this specification was present but metalinguistic limitations made it difficult for children to consciously access the knowledge and to verbalise it (Karmiloff-Smith, 1992). However, a simple distinction between production and comprehension fails to explain why performance on the drawing task was better than that on the comprehension task. Part of the reason for this, as discussed in the previous chapter, could be the way the two tasks were scored or the nature of the processes involved in those tasks.

The findings also highlight the difference between the lexical decision and naming tasks. Although, children were able to recognize the phonological form of most of the target words in the lexical decision task, they usually failed to produce these phonological forms for the majority of the targets items in the picture naming task. These findings indicate that even though children are able to access information about the phonological form of a novel word (lexical decision), and partial information about its salient visual characteristics in the drawing and comprehension tasks, the integration different types of representations was problematic. This suggests that although imprecise representations (or a *roughed-up map* to borrow Carey's expression (1987)) of the lexical item has been created, the children had more detailed knowledge of some localities of the 'map' than others, and that they had problems using their lexical map because the relations between different forms of knowledge were not specified in enough detail when information had to be retrieved from memory.

4.2. Nature of the Input and Word Learning Performance

Two inter-related issues are addressed in this section. Namely, whether certain forms of input were more effective than others in helping children form lexical representations, and whether children could transfer information cross-modally (i.e. from auditory to visual and vice versa).

There were significant differences in performance between conditions (both in terms of the content of the knowledge gained about novel target items, but also in terms of how quick children were to access this knowledge). Children in the Speech condition were significantly less accurate than children in the visual condition on 4 out of the 5 assessments where the means were higher (see Table 7). There was also a suggestion that children in the Speech condition had less developed representations than children who were shown pictures Interestingly, the only task where children in the Speech condition performed similarly to those in the other conditions involved lexical decisions, and this suggests that the children learnt the phonological form of the word equally well irrespective of any additional, or accompanying, semantic or visual information. In relation to their timed performances, children in the Speech condition also tended to be faster on the comprehension task and to take significantly less time to provide definitions or to draw the novel target items. Some of these effects may have been due to children in the Speech condition having less elaborate or detailed representations and so they took less time to provide definitions and drawings than children in the other conditions.

Another feature of the findings was the lack of a significant difference in the performance of children in the Visual and the Combined conditions. Thus, the 'extra' semantic information in the Combined condition did not result in superior performance for these children, even though they were given semantic information that was not present in the Visual condition. This suggests that children in the Visual condition were able to use the pictorial information to deduce semantic characteristics of the target item. A related finding is that the provision of explicit semantic information in the Speech condition did not facilitate the children's performance on the definitions task. In fact the children's performance in the Speech condition was significantly worse than that of children in the Visual condition, suggests that visual information may have been more helpful in creating semantic categories than explicit semantic information present when only provided in speech. One should however, exercise caution when interpreting these findings as it might be worth trying to differentiate these two types of exposures (i.e. 'semantic' and visual) more closely.

It also is apparent that children in the Speech condition were able to draw items, correctly identify pictures in the comprehension task and name pictures, even though performance on these is heavily dependent on having a visual representation of the target. This suggests there was cross-modal transfer so that children in the Speech condition were able to utilise semantic information presented in a verbal context to build a visual representation of the target items. However, it also was the case that even though children were able to build visual representations to assist their performance on these tasks, their performance was significantly below children in the other conditions.

The current investigation has extended the scope of previous research by showing that learning could take place even in the absence of visual information about the referent. It is possible to relate these findings to a study by Hall and colleagues (1997) where the authors examined university students' comprehension of scientific explanations (i.e. understanding how a *pump* works) by manipulating how the information was presented. The authors found that although students learned in contexts with and without pictures, the information presented via pictures was more effective than using words to describe the novel word. Although there are differences in the methodologies of the two studies (Hall and the current research), similar conclusions can be reached in that learning can take place without seeing pictures.

We can also relate these results to the argument put forward by Funnell and colleagues (2004; see also Hall et al, 1997) about the way word learning experience can have repercussions on the types of representations that children can form (and/or acquire) about novel words. In their study investigating 3 to 7 year olds, Funnell et al. found that seeing an object helped children to develop a more detailed representation of this object. And as shown in the current study, children in the combined condition tended to acquired more extensive, or complete, lexical knowledge (compared to children in the Speech only condition).

V. CONCLUSION

The current findings indicated that all children acquired knowledge about the novel target words. The findings also revealed that certain forms of lexical knowledge about the target items were more difficult to acquire. For example, children were able to identify most of the target items in a lexical decision task, but were unable to produce the phonological form of the target items in a picture naming task. The findings also indicated that children were able to recode information into different modalities to build up the content of their lexical entries. For example, children were able to use semantic information to create visual images of the target items and as a result be able to draw aspects of the target, and they also were able to use visual information to create semantic entries for the target items. However, despite children's abilities to recode information the absence of visual information, children in the Speech condition appeared to be at a disadvantage. This suggests that visual information is a particularly powerful facilitator for word learning in young children.

CHAPTER IX

GENERAL DISCUSSION

I. Introduction

The primary concern of this thesis was the investigation of lexical access and production in typical populations of primary school-aged children. The current research focused on two aspects of lexical processing, namely (picture) naming and word learning. The first section of the Discussion reviews the main findings of the individual chapters of the thesis. The implications of these findings for future research will be considered in a second section.

Why study was set up

The current investigations were designed to broaden our understanding of two interrelated lexical processes: naming and word learning. The current research was also initiated because of an interest in typical populations of children. Indeed, knowing more about typical development might enable a better understanding of those processes involved in children who experience naming failures or word learning deficits. Furthermore, few studies have looked at typical development as most of the investigations of naming processes in older children have focused on children with language disabilities. Although the use of control groups in these studies provides information about typical development, there is still much knowledge to be gained by studying typical populations in a comprehensive manner. In relation to the process of lexical acquisition, a large literature is available about younger children (up to 5 – see Table 1; Chapter VI), but fewer investigations have been conducted. Consequently, it was decided to focus on a wider developmental age range by investigating typical school-age children from 6 to 11 years of age.

Investigations of the lexical performance of children with language disabilities have indicated problems with language on a number of dimensions. These children tend to be significantly slower at naming; they also tend to produce significantly more errors than typical matches (see Chapters III to V). A common view in the literature is that children with language disabilities also tend to be less able to acquire knowledge about new words or word meanings (Nash & Donaldson, 2005; also see Chapter VII and VIII).

Several important explanations of these difficulties have concerned the semantic or phonological components of language processing. As already discussed (Chapter I and VI), there are nevertheless limitations to the methods used in previous research. Chapter I illustrated how relatively few studies of children's naming processes have used a comprehensive approach to investigate semantic abilities, phonological abilities as well as speed of information processing in the same children. Instead, previous research has focused on one or two processing factors. As a result, little is known about the abilities enabling children to name quickly and accurately (D'Amico et al., 2001; Johnson, 1992; Johnson et al., 1996). A similar limitation concerning the restricted range of tasks used to investigate the process of lexical acquisition was discussed in Chapter VI. Indeed, several authors have urged for a need to go beyond the use of multiple-comprehension tasks to assess the presence of learning (Beck et al., 1991; Gaskell & Dumay, 2003; Miller, 1999). The argument put forward by these, and subsequent researchers (Funnell et al., 2004; Ralli & Dockrell, 2005; Vosniadou, Skopeliti & Ikospentaki, 2004), was that what children know about a (novel) word cannot be captured by simply pointing to a picture – where other factors such as guessing can be involved (Anglin, 1993).

These limitations have been addressed in the present thesis by adoption of a range of tasks tapping into different types and levels of semantic and phonological abilities, but also tasks tapping into speed of processing. Accuracy of response was recorded and the data was complemented by using both latency of response and duration of response on the range of assessments used. Indeed, as argued by Levelt and colleagues (see also Schiller et al., 2003), the reaction time paradigm – which consists in measuring children's time of response on a range of tasks, is believed to provide an additional methodological tool for understanding more about lexical processes. And although measures of speed of response have been used in studies of adult production and comprehension and with atypical populations of children, there is a need to extend the current knowledge-base concerning those factors and processes that underpin typical lexical access and production.

There is a consensus that when investigating lexical processes, there is a necessity to employ a range of assessments. As discussed above, different tasks tap into different levels of abilities and some tasks can be more difficult than others. Therefore, if performance is impaired on a particular task, this might not necessarily indicate a lack of knowledge but instead a difficulty due to the type of task used. As discussed in Chapter VI, initial studies of word learning mainly used multiple-choice comparison tasks to assess whether learning took place. However, such forced-choice comprehension tasks fail to provide a comprehensive picture of what has been acquired. Findings that children can choose the correct (target) picture therefore do not necessarily mean that children have acquired extensive (or complete) knowledge about the semantic and/or phonological properties of the word – such as being able to give a definition or capturing its physical or acoustic characteristics and so on. This further exemplifies Funnell et al., 2004 (also see Barrow et al., 2000)'s distinction between *knowing the name* of a novel word and *knowing about the properties* of the new word. As Donaldson & Laing (1993) summarised, comprehension and production tasks involve different processes and whereas language comprehension involves the "*receptive function of language*", production relates to the "*expressive function of language*" (p.161) and both are bound to capture processes that differ in fundamental aspects (p.159).

Knowing about a word encompasses a range of knowledge that is not captured by MCTs (Barrow et al., 2000; Beck et al., 1982; 1991; Funnell et al., 2004; Vosniadou et al., 2004). As a result, there is a need to use a range of assessments in order to investigate the knowledge that children possess about new words. Another example of limited methodologies is when knowledge is assessed with complex tasks – such as the use of definitions which require metalinguistic knowledge, whereby children need to consciously reflect on their answers and subsequently verbalise this knowledge. Thus, poor performance on definitions might not reflect a lack of knowledge but simply, a difficulty to verbalise knowledge that children possess (Karmiloff-Smith , 1992; Kempler et al., 1998).

Another area of research where knowledge is lacking concerns the use of tasks involving speeded performance. There is currently a lack of a comprehensive framework to the study of naming processes and few studies have used the reaction time paradigm to investigate children's lexical processes (Cycowicz et al., 1997; D'Amico et al., 2001). Previous studies of naming processes have mainly examined speed of discrete or serial naming but not speed of response on other related cognitive abilities. Similarly, rarely have studies of children's lexical acquisition looked at speed, or duration, of response (but see Dockrell et al., 2006c).

Therefore, in order to take these issues further, through a cross-sectional investigation of 6 to 11 year olds, the current thesis set out to explore typical children's naming and word learning abilities. It was decided to expand the scope of previous work and adapt – as well as complement - the methodology used in these earlier studies. As a result, a range of assessments tapping into different cognitive abilities was used (see Chapters I-II and VI-VII for details of the tasks used and rationale). The comprehensive set of methods used in these studies was based in part on research on atypical populations of children with language and reading disabilities.

The aim of these investigations was to assess the relative contribution of different types of lexical representations to the naming and word learning processes in typical populations so as to identify the sets of abilities that enable children to name quickly and accurately but also to learn more efficiently. The aim was to provide a comprehensive picture of the lexical system when naming and learning new words.

II. Lexical Representations and Lexical Processes

This section considers the main findings emerging from the current research. These concern lexical representations and lexical processes, as well as the role and contribution of general information processing speed to lexical processes.

2.1. Lexical Representations in relation to Naming and Word learning

Lexical representations are usually believed to involve both semantic and phonological components (Lahey & Edwards, 1996; Levelt et al., 1999). As discussed previously, the importance of lexical representations in relation to successful (i.e. faster and more accurate) naming (McGregor, Newman, Reilly & Capone, 2002b; Truman & Hennessey, 2006) or word learning (Demke et al., 2002; Nash & Donaldson, 2006) has been documented in populations of children with language disabilities. In typical children, one would expect the semantic and phonological components of language to be unimpaired. However, a relevant question is to investigate the relative contribution of different types of lexical representations to the naming process. A better understanding of the naming operation might enable a better appraisal of the types of processes or representations that are associated with successful naming. A similar interest lies in the variables involved in lexical access in relation to word learning.

Importance of semantic processing abilities (or representations)

The importance of semantic processing abilities has been highlighted in several places in the current thesis. These involved: findings from the error study (Chapter V) highlighting children's difficulties in accessing semantic information; findings from the naming studies (Chapters III and IV) identifying specific measures of semantic ability as significant predictors of speed and accuracy of discrete naming; and finally from the investigation of word learning processes (Chapters VII and VIII) assessing the effects of different types of input for word learning. These points will be considered in turn.

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A common view in the literature is that analysis of the type of naming errors can pinpoint to the locus of impairment (Dell et al., 2000; Levelt et al., 1999). Although some researchers have questioned the validity of this technique to draw conclusions about either the presence of a semantic or a phonological deficit in the language system, there are nevertheless suggestions that such an approach could at least be indicative of a problem in a particular component of naming (German, 1989; McGregor, 1997; Newman & German 2002; 2004). Error analysis from the current findings emphasised that all children produced a high rate of semantic errors and few phonological errors. In addition there was a significantly higher rate of *don't know* responses from the language-impaired sample than in the other two groups. An implication of the research is that difficulties in accessing semantic information are the most common cause of inaccurate naming. Additional analysis on the role of lexical factors showed that although frequency and neighbourhood density were related to the error rate of children with WFDs, there were no significant correlations between lexical characteristics of the target words and performance of the typical children. It is unclear why this was the case. Explanations might relate to the fact that the number of items used in the current research was too small, or to the fact that the role of lexical factors might change with age, or even that the word frequency counts did not match the experiences of the children. Thus, it is also possible that lexical factors might impact on typical and language disabled populations differently and further research could address these issues in order to gain a better understanding of the role of lexical factors in relation to lexical development.

In light of these findings about the importance of semantic knowledge, it was decided to investigate more thoroughly the types of lexical and cognitive abilities that are involved in the typical naming processes (Chapters III and IV). Findings from these chapters (see output from correlational and multiple regression analyses) suggested the importance of semantic processes in relation to naming. Moderate and significant correlations were found between the speed of response on the semantic categorisation task and discrete naming (see chapter III). Although it should be acknowledged from the regression analyses that the speed of response on the semantic categorisation task was not identified as a significant predictor of discrete naming. In addition, other variables identified as a significant predictor of the accuracy of discrete naming were the children's scores on a semantic fluency task which assesses children's ability to look for relations between objects, scores on a category verification task which assesses children's ability to verify the relationship between different categories of objects and children's vocabulary size. Thus, the output from the multiple regression analyses indicated that semantic variables made an independent and significant contribution to children's accurate and fast naming of discrete pictures.

A final strand of evidence concerning the importance and difficulty in acquiring semantic information comes from data from the word learning investigations (Chapters VII and VIII). One of the questions addressed in the word learning chapters concerned the relative contribution of a speech input containing additional semantic information compared to a visual input (where pictorial stimuli 'replaced' the extra semantic information presented in words) and a combined type of input with both types of information. Children in the speech condition performed less well than children in the visual and combined conditions, indicating a difficulty in acquiring and accessing semantic information. In addition, performance on tasks tapping into semantic knowledge (i.e. definition task) and involving the integration of semantic and phonological processes (such as the picture naming task) were more difficult. In other words, children seemed to learn less about the semantic properties of the novel words introduced in an incidental type of learning context. The current findings therefore provide converging evidence regarding the importance and the status of semantic representations in the lexicon. Indeed, the availability and, more or less easy, access to semantic representations appears essential for lexical processes such as naming or word learning.

Importance of visual representation for learning

As seen throughout Chapters VI to VIII, lexical acquisition was assessed by several tasks comprising naming, giving definitions, drawing, discriminating between auditory competitors and the target items. The findings revealed that children in all three conditions (i.e. visual, speech and combined) 'learnt' and this was not attributed to chance responding or guessing. However, the results indicated that children in the speech condition, who received explicit semantic information to compensate for the lack of visual input, performed worse on assessments of word learning than children in the two other groups. Thus, although the provision of speech input on its own was sufficient to establish novel words in memory (as assessed by tasks tapping into the semantic and phonological specification of the novel words), the provision of semantic and visual information (or visual information alone) were of greater assistance in establishing lexical representations in memory. It is possible that enough semantic information was already present in the pictures to support word learning, (McGregor et al., 2002) and therefore, additional explicit (semantic) verbal information was not needed in order to establish word meanings. This finding is in line with the argument put forward by Funnell and colleagues (2004) about the importance (or 'superiority') of visual input conditions. Indeed, these authors argued that accurate naming was influenced by the provision of "*prior personal experiences with objects that allow detailed perceptual-structural descriptions of the physical properties of objects to be constructed*". As a result, new words that were presented "*in association with [the] detailed and specific visual information*" tend to be more accurate (Funnell et al., 2004; p. 287). It is possible to relate these findings to previous work where, for example, Hall and colleagues (1997) argued that although speech information could be effective in building connections between a new word and a specific meaning, visual information or what the authors label as *accurate visual representations* (p.677) are worth ten thousand words. According to these authors and the findings of the current thesis, visual information appears to be more helpful to establish and/or consolidate the new word in memory.

Importance of phonological processes

Data from the naming studies showed the relative importance of phonological representations for the speed and accuracy of both discrete and serial naming. As discussed above, an important predictor of discrete naming accuracy was identified as raw scores on the BPVS (i.e. measure of receptive vocabulary). The BPVS is believed to provide an overall indication of semantic and phonological knowledge about words. Another predictor of discrete naming accuracy was scores obtained on the phonological awareness task. Finally, in relation to serial naming speed, scores on the lexical decision task were identified as accounting for a significant portion of the variance of this dependent variable (see Chapters III and IV for details). An implication of these findings is that phonological processing skills make a separate and independent contribution to both forms of naming.

Further insight into the role of phonological representations stems from the investigation of word learning (Chapters VII and VIII). One of the research questions was to investigate the forms of lexical representations that were formed and subsequently displayed by children after learning new words. The current findings showed that some forms of lexical knowledge were easier to access than others. Specifically, children found it easier to acquire the phonological specification of novel words whereas, as stated above, there appeared to be more difficulty in accessing and/or forming the semantic specification of the novel target items. The findings from Chapter V (analysis of error patterns) provide further support concerning the easy access to the phonological form of words. As Chapter V showed, when naming common objects or actions, there was no significant difference relative to the type (and number) of phonological errors between children with WFDs as well as their typical age- and language-matched peers. These findings suggest that the phonological representations of the language-impaired sample were unimpaired.

Summary: The current results, from both naming and word learning studies present evidence of a differentiation between access to semantic and phonological representations and therefore reinforce the notion that semantics and phonology are important component processes for lexical access and lexical acquisition.. The distinction between the contribution of semantic and phonological knowledge is highlighted when contrasting the naming and the word learning studies of the thesis. Nevertheless, it also seems clear from the data obtained, that both types of abilities make independent, and separate, contributions to accurate (and faster) naming. Knowledge about the phonological form of words and their semantic specification are also important to establish new words in memory. Moreover, investigation of children's learning processes also appears to suggest that access to semantic information was more difficult to acquire.

2.2. Importance of Speed of Processing to Naming (discrete and serial)

As discussed earlier on, the reaction time paradigm has rarely been used in developmental approaches of children's lexical processes. It was therefore decided to expand the scope of previous work by measuring children's speed of response on naming tasks, but also on other sets of lexical and non-lexical abilities. The analysis of response times was used as an additional methodological tool to gain further insight into children's naming and word learning processes.

In relation to the naming studies, two types of information were available: accuracy of response provided information about the content of the lexicon or the integrity of the representations in the children's lexicon. Measures of speed of response on the other hand emphasised the efficiency with which children accessed this information. In relation to the word learning studies, the response time measures seemingly assessed the strength of the connections formed during word learning. Thus, a faster response time could reflect stronger connections (and consolidation) of the information in the lexicon.

The main aspects that will be discussed in this chapter concern the relation between the two types of naming speed (i.e. serial and discrete) and the contribution of non-lexical speed of processing to the prediction of speed and accuracy of naming.

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Naming speed: serial naming vs. discrete naming

There is a lack of research investigating whether serial and discrete naming procedures are related. This aspect has been broached by previous work but there has not been a direct comparison between children's performance on those two naming tasks (but see Berninger et al., 1997; Bowers, 1993). The current investigation of typical children's naming showed moderate correlations between the two forms of naming. In other words, it would appear that the serial and discrete naming formats share similar processes but do not capture exactly the same abilities. To extend the research, further analyses were conducted about the predictors of both types of naming so as to identify whether similar processing abilities were involved. Although there has been a resurgence of interest concerning the RAN (Cobbold et al., 2003; Georgiou et al., 2003; Neuhaus & Swank, 2002), there is still uncertainty about the cognitive processes involved in this task. The current findings indicate that both types of naming are dependent on development and maturation. In other words, speed of discrete and serial naming are dependent on general ability (age was identified as the first predictor in the regression analyses; see Chapters III and IV). The findings from the current investigation indicated that serial naming speed was related to speeded automatic processes (i.e. speeds of response on the counter pressing and simple motor tasks) and access to phonological codes (i.e. the lexical decision task). This corroborates the hypotheses put forward by Denckla & Cutting (1999) that the RAN would provide a measure of rapid efficient responding (Wolf & Bowers, 1999).

On the other hand, the main predictors of discrete picture naming were age, measures of semantic ability (speed of categorisation, measure of semantic fluency and vocabulary size (see Chapters III and IV for details of correlations and regression analyses). This is consistent with, for example, Wolf & Obregon (1992)'s claim that discrete naming reflects a complex form of word-retrieval, with emphasis on the extraction of *higher-level* semantic processes. A further distinction concerned the processes that predicted the speed and the accuracy of discrete naming. Hierarchical regression analyses further served to differentiate between the cognitive processes involved in speed and accuracy of discrete naming. Whereas speed of discrete naming was more reliant on general ability (age was identified as the first predictor), discrete naming accuracy was more dependent on the content of the lexicon and the integrity of the semantic and phonological representations. Thus, it would appear that speed of discrete naming and accuracy of discrete naming involve different cognitive processes.

Speed of processing as an additional variable to the naming process

The current data from the study of typical children's naming processes provided information about the relation between speed of response on non-lexical tasks and both speed and accuracy of naming. As shown in Chapters III and IV, there were strong (and positive) correlations between speed of response on the counter tapping, simple and motor tasks and accuracy on discrete naming, but also with accuracy on other components of language ability such as measures of receptive vocabulary, semantic categorisation, phonological awareness and so on, involved in the naming process.

In order to take the analysis further, multiple regression analyses were conducted to assess the relative contribution of lexical and non-lexical processes to both discrete and serial naming. The findings provided further insight into the relationship between speed of response on non-lexical tasks and speed of naming, supporting the idea put forward by Kail and other researchers in that there is a general mechanism regulating speed, so much so that slower naming speed was related to slower speed of processing on a range of abilities irrespective of the type of material used i.e. lexical or non-lexical (see Leonard, Ellis-Weismer, Miller, Francis, Tomblin & Kail, 2007).

Although age was a significant predictor of discrete naming speed, strong correlations were also obtained with the speed of tapping and speed of response on the simple motor task, but also with speed of response on the semantic categorisation (see Chapters III and IV for details). These findings are consistent with the notion that if children are able to access and/or sift through semantic information (that is organised in the network of association) or information about category membership faster, then children are able to retrieve the name of the target faster. Further evidence of the close relationship between speed of response on non-lexical tasks and discrete naming was also provided by looking at the predictors of discrete naming accuracy (see Table 12; Chapter IV). Contrary to what might have been expected, it is not so much speed of response on tasks involving lexical stimuli that were identified as the critical predictors of discrete naming accuracy. Instead, speeds of response on the counter tapping and on the simple motor tasks made independent and separate contributions to the prediction of naming accuracy. These findings might suggest that – at least for typical populations, there might be a closer relationship between a general information processing ability that would underlie lexical processing. There are therefore indications that the language system is more integrated than one might initially expect and that a general, common, component of speed underlies lexical and non-lexical processing abilities. This suggests that speed and accuracy measures are intricately related, and that the language system is not as differentiated as one might initially expect (also see Tomblin & Zhang, 2006).

Another implication of the current thesis for understanding atypical development is that language can 'fail' (e.g. naming or learning) not only when a specific part or aspect of lexical production is affected such as semantics or phonology. As the current research emphasised, the importance of speed of information processing supports the notion that speed of information processing may well be a cause of, or exacerbating, children's language or literacy difficulties. Indeed, a lot of research on literacy and poor comprehenders has assumed that the locus of these children's difficulties was with their lexical representations. This has been challenged by Wolf & Bowers (1999) who implicated speed of naming as a potential cause of these children's difficulties. However, this argument has not been resolved to date and there is still ongoing debate as to the role of speed of information processing in relation to children's reading disabilities. Findings from the current research (see output of regression analyses in relation to naming studies – i.e. Chapters III and IV) challenge the assumption that the difficulties experienced, for example by poor comprehenders or children with literacy difficulties, are due to either semantics or phonology, i.e. where a specific part of the lexical system is impaired. In contrast, the current results are consistent with Wolf & Bowers (1999) or Kail's work (Kail, 1994; Kail et al., 1999) concerning the fact that a general information processing component may play a part in, and affect, language processes. As summarised recently by Leonard et al. (2007; p. 422): "*[...] non-linguistic cognitive speed or general speed [play] a significant role in accounting for the variance in children's language*".

Work from adult populations concerning the role of speed of information processing, indicated that faster processing speed was strongly related to intelligence. In other words, adults who can process information or resolve tasks faster were believed to be more intelligent. Jensen was one of the first to investigate this issue and showed how speeded performance on perceptual detection tasks was related to *measures of higher-order cognition* such as fluid intelligence or short-term memory (Jensen, 1980; 1982; 1987). Later work by Anderson has revealed the presence of strong correlations between the time taken to discriminate between perceptual stimuli (labelled as *inspection time*) and measures of intelligence (Anderson 1986; 1998; Eysenck, 1988; Jensen, 2000; Nettelbeck, 1987; Nettelbeck & Lally, 1976). As Vernon (1990) illustrated, speed of information processing could be the basis of general intelligence and from this perspective, ought to be considered as an integral component of lexical processing or in these investigations, used as a co-variate when examining the effects of other variables.

The current findings therefore emphasise the need to consider the role and/or contribution of general speed of information processing - as well as measures of lexical ability such as semantic and phonological representations, as variables that can affect the naming process. Moreover, it appears that speed of information processing is part of a general ability and when affected, will have repercussions on naming speed but also on a range of other (cognitive) abilities. Implications of the current findings suggest that slower processing can negatively affect lexical processing. Moreover, as argued by Lahey & Bloom (1994), slower processing speed can also have implications for language assessments and intervention.

III. Implications for Future Research and General Conclusions

Application to Atypical Development

Another implication of the current research investigations is that a better understanding of typical processes (whether picture naming or lexical acquisition) can help inform the development for atypical populations. Specifically, the findings from this thesis presented a more comprehensive picture of the way that different cognitive abilities were related to lexical access. There is evidence of an integrated language system where semantic, phonological, visual representations as well as speed of information processes are all inter-related and underlie language processing as a whole. Thus, it seems that the route for understanding language disabilities might not rely on either semantics or phonology but instead, might involve both of these components of the naming system (as they each make separate and independent contributions to children's fast and accurate naming and word learning). Similarly, in relation to research into word learning, one of the major aims of the investigation was to investigate how the information might best be presented to children in order to enhance, or facilitate, children's understanding of novel words

Although the current findings highlighted the role of separate components of the lexical system to naming, it also was the case that the research indicated that in typical development many components of the lexical system are related to one another. This was particularly clear in relation to Chapter IV, where the relationship between accuracy and speed variables on lexical tasks but also on non-lexical tasks was examined. The findings indicated interrelationships between measures of naming, semantic and phonological ability. The implication was that if children possessed accurate information about one aspect of lexical processing, they are more likely to display more accurate information about another aspect of the lexical system but also tend to be 'better' (i.e. more accurate) at naming. Evidence of the presence of an integrated language system is not unduly surprising as Tomblin & Zhang (2006) recently discussed in relation to typical children. Indeed, these authors assessed children's performance on a range of lexical abilities (by assessing children on several standardised language tests) and at different ages (from 6 to 14). A factor analysis showed evidence of a single dimension or factor underlying the language system at each of the 4 ages investigated. According to Tomblin, a differentiation between vocabulary and grammar was only observed later on in development (at 13-14 years).

The current research also emphasised the need to examine speed of information processing as a variable that can affect the naming process. As illustrated by the findings of this thesis, slower information processing might play a part in slower, and less accurate, naming or word learning. Therefore, taking into account the speed of information processing can be useful not only to investigate lexical processes but might also be a tool used to the identification and detection of children who might exhibit language difficulties. As hypothesised by Lahey & Edwards (2001), there might be a threshold level for speed of information processing below which language would be impaired, but above which there would be no impairments. Thus, examination of response times might serve as a basis for the detection of problems with language use (and/or language learning). This in turn, could help set up remedial procedures or intervention. Or simply put, investigation of speed processes in typical populations can be seen as a marker to identify potential areas of difficulties or problems with subsequent language learning and language use.

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As discussed by several researchers (Johnson, 1992; Vance et al., 2005), interest in the reaction time paradigm and in the patterns of performance observed in typical development could also serve as a basis towards understanding typical development and (the development of theoretical) naming models. It is indeed possible to adopt similar methodologies as that used for example by Levelt and colleagues (1999; Schiller et al., 2003; Levelt et al., 1991) to study the time course of the different processes and stages involved in children's naming. Although this has not been the purpose of the current thesis, adopting such a framework (chronometry) would nevertheless contribute to further existing knowledge in typical lexical processes. Indeed, as already discussed, models of children's naming are rare and have been adapted from adult models. A focus on chronometric measures on children populations might enable comparisons with adult models (Levelt et al., 1999).

There is a further need to consider the practical application of these findings for typical populations. As Greenwood (2004; p.28) recently argued: "*There is a great divide between what we know about vocabulary instruction and what we often, still do*" (see also Bromley, 2007). It is thus important to build on current research investigations to help build (or provide support to) children's vocabulary. This is also of particular import in relation to children with English as a Second Language, children with poor vocabularies and/or children with language disabilities. Indeed, the investigation of word learning highlighted the importance of providing a visual context when introducing new words. This is a particularly important point to consider when dealing with children who have language disabilities. These children already have a problem with language and lexical representations, thus might be less able to rely on semantic information to extract word meanings. In all likelihood, these children might experience more difficulties with lexical acquisition if they are denied visual 'props'.

Research into typical processes is therefore important for understanding the mechanisms underlying difficulties in naming or learning new words. A better understanding of these lexical processes can lead to better diagnostic procedures and, as discussed before, could help guide intervention and/or remedial programmes (Kohn & Goodglass, 1985; Lahey & Bloom, 1994).

Taking the Research Further

Although cross-sectional investigations of typical naming and word learning processes provided important findings, a longitudinal study might provide clearer and more definite answers to the issues considered in the current thesis as well as a better appreciation of the issues addressed (such as for example, which cognitive processes at one point can accurately predict children's language status later on). Age was found to be an important predictor of naming, and it can be argued that age provides an approximate indication of general ability. As a result, in future research, it might be worth including other measures to control for general ability (such as non-verbal skills, general intelligence or memory capacity and so on).

Another issue to consider in relation to the word learning studies is the relatively small sample size. This might have compromised the power of the analyses, especially in the first study (which comprised only 20 children). Therefore, it would be interesting to take this issue further by using a greater range of children (of both genders) and with schools from similar catchment areas. In order to extend the field of knowledge, further research could also consider lexical acquisition in a variety of settings. Indeed, the current research focused on a semi-naturalistic context (by adaptation of Rice's QUIL paradigm) but it is worth bearing in mind that children learn in other types of direct or instructional contexts (e.g. classroom settings) or informal settings (such as listening to stories, or in informal conversations). It is possible that these differentiated contexts might entail different findings. For example, one might find that a particular word learning situation might require less exposure to novel words in order to observe vocabulary gains. Another noteworthy issue to take the studies forward would consist in comparing children's performance on different categories of words – for example by using more words belonging to different categories or by looking at the acquisition of nouns vs. verbs and so on.

Finally, although the current research used a novel way to investigate lexical processes related to naming and learning, one ought to exercise caution when generalising the findings. The conclusions reached in the current work are limited by the age range under investigation, by the relatively small sample size and by the small number of (target) words used. It might also be worth using a greater range of non-lexical tasks to resolve issues concerning the use of response time measures (i.e. prone to errors of measurement) although this has been addressed in the thesis by using a range of test items for each of the tasks used.

Conclusions

This thesis has involved an investigation into the role of lexical representations in relation to typical children's accuracy and speed of naming, as well as the way lexical representations are established (and consolidated) when novel words are acquired. The current findings reinforce the need to consider the contribution of speed of information processing but also the integrity and accessibility of lexical representations to efficient naming and learning processes. The output from the regression analyses in particular indicate that semantics and phonology are two separate components of the language system that make independent (and significant) contributions to the naming process, but also to word learning. As a result, if any one of these components is affected, naming or word learning will be affected. Data stemming from the learning studies further suggest that acquisition of the phonological specification of words might be easier than acquisition of the semantic properties of words. The output from the regression analyses also seem to indicate that age was not the only (or the most) important factor to drive the naming process.

The research also has highlighted the importance of using response times in the study of lexical processes and the need to examine speed of information processing as another variable that can affect the naming process. This provides support for Kail & Salthouse (1994; p. 199)'s argument that: "*speed of information processing [ought to be] viewed as a fundamental part of the architecture of the cognitive system*". As illustrated by the findings of this thesis, slower information processing appears to affect lexical processing. Therefore, taking into account the speed of information processing can be useful not only to investigate lexical processes but might also be a tool used to the identification and detection of children who might exhibit language difficulties and therefore, ought to be an important feature to look at in future research.

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APPENDICES

APPENDIX A – CHAPTER II

Selection of items used for the discrete picture naming task

All pictures selected from the standardised "Expressive One-Word Picture Vocabulary Test-Revised" (Gardner, 1990)

The items are grouped according to the expected age range for production given in the EOWPVT-R.

- Age range: 3:6-4:5
    1. Fireplace
    2. Tyre
    3. Computer
    4. Animals (super-ordinate)

- Age range: 4:5-5:11
    5. Fruit (super-ordinate)
    6. Skeleton
    7. Mermaid
    8. Tractor
    9. Stool
    10. Furniture (super-ordinate)
    11. Pineapple
    12. Ostrich
    13. Binoculars

- Age range: 7:0-7:11
    14. Wishing well
    15. Lamb
    16. Saddle
    17. Thermometer
    18. Cactus

- Age range: 8:0-9:11
    19. Clouds
    20. Spanner
    21. Compass
    22. Paw
    23. Trumpet

- Age range: 10:0-11-11
    24. Anchor
    25. Propeller
    26. Screw
    27. Stump
    28. Tweezers
    29. Chess
    30. Bulldozer

APPENDIX B – CHAPTER II

Percentage accuracy for the discrete picture naming task at each age group

WORDS	YEAR 2 [N = 35]	YEAR 4 [N = 35]	YEAR 6 [N = 35]
w1 Fireplace	20.0	65.7	57.1
w2 Tyre	31.4	51.4	60.0
w3 Computer	94.3	94.3	91.4
w4 Animals	71.4	82.9	94.3
w5 Fruit	77.1	77.1	91.4
w6 Skeleton	80.0	91.4	100.0
w7 Mermaid	82.9	94.3	100.0
w8 Tractor	60.0	82.9	80.0
w9 Stool	11.4	57.1	65.7
w10 Furniture	20.0	54.3	57.1
w11 Pineapple	60.0	91.4	97.1
w12 Ostrich	20.0	62.9	62.9
w13 Binoculars	34.3	65.7	85.7
w14 Well	31.4	60.0	91.4
w15 Lamb	48.6	68.6	62.9
w16 Saddle	8.6	25.7	42.9
w17 Thermometer	8.6	74.3	68.6
w18 Cactus	14.3	48.6	74.3
w19 Clouds	88.6	100.0	100.0
w20 Spanner	25.7	37.1	68.6
w21 Compass	8.6	51.4	82.9
w22 Paw	45.7	57.1	77.1
w23 Trumpet	65.7	82.9	77.1
w24 Anchor	45.7	68.6	82.9
w25 Propeller	2.9	22.9	25.7
w26 Screw	45.7	34.3	42.9
w27 Stump	2.9	11.4	34.3
w28 Tweezers	14.3	25.7	42.9
w29 Chess	60.0	91.4	100.0
w30 Bulldozer	5.7	5.7	5.7

APPENDIX C – CHAPTER II

The items used in the lexical decision task

20 Words

Practice trial: => Bird, Apple, Train.

Test items (/20)

1. Stump*	
2. Propeller*	
3. Spanner*	
4. Bulldozer*	
5. Tweezers*	
6. Cactus*	
7. Saddle*	
8. Compass*	
9. Ostrich	
10. Mermaid*	
11. Skydiver**	age range: (10:0-11:11)
12. Observatory**	age range: (10:0-11:11)
13. Celery**	age range: (8:0-9:11)
14. Pillar**	age range: (10:0-11:11)
15. Rodents**	age range: (10:0-11:11)
16. Pier**	age range: (10:0-11:11)
17. Elf**	age range: (8:0-9:11)
18. Hoof**	age range: (10:0-11:11)
19. Symbols**	age range: (10:0-11:11)
20. Hexagon**	age range: (10:0-11:11)

***: words used in the discrete picture naming task**
****: words not used in previous task(s)**

20 Non-words

Practice trial: => Noast, Plit, Dort

Test items (/20)

1. Pleck --
2. Cactul ---
3. Sorage ---
4. Bink ---
5. Sutter ---
6. Genium ---
7. Centle ---
8. Nogic ---
9. Mose ---
10. Lorse (*)
11. Celtar ---
12. Geniar ---
13. Drace ---
14. Inlect ---
15. Peroic ---
16. Klower ---
17. Barrot (*)
18. Sleece ---
19. Girter ---
20. Foad ---

(*): non-words chosen from Temple, 1984
---: non-words chosen from Masterson, 1989

APPENDIX D – CHAPTER II

Items used in the semantic categorisation task

Fixed order of main categories – "animal", "bird", "fruit", "lamb", "stool", "vehicle" but presentation of items within each category randomised.

<u>List of items:</u>

	1. ANIMALS		Coding Response
		Examples used:	If children say examples belong to the category, the answer is coded as:
DISTINCTION	Central	Dog, horse	Correct
	Peripheral	Tortoise, crocodile	Correct
	Alike	Flower, robot (wind up toy)	Incorrect
	Different	Hat (Stetson), plane	Incorrect

	2. BIRD		Coding Response
		Examples used:	If children say examples belong to the category, the answer is coded as:
DISTINCTION	Central	Duck, swan	Correct
	Peripheral	Penguin, ostrich	Correct
	Alike	Bat, kite	Incorrect
	Different	Giraffe, eadphones	Incorrect

	3. FRUIT		Coding Response
		Examples used:	If children say examples belong to the category, the answer is coded as:
DISTINCTION	Central	Banana, apple	Correct
	Peripheral	Pineapple, lemon	Correct
	Alike	Radish, carrot	Incorrect
	Different	Candle, butterfly	Incorrect

4. LAMB		Coding Response
	Examples used:	If children say examples belong to the category, the answer is coded as:
Alike	Sheep, cow, goat	Correct
Different	Doll, microwave, tree	Incorrect

5. STOOL		Coding Response
	Examples used:	If children say examples belong to the category, the answer is coded as:
Alike	Office chair, wooden chair, table	Correct
Different	Bucket, syringe, violin	Incorrect

	6. VEHICLE		Coding Response
		Examples used:	If children say examples belong to the category, the answer is coded as:
DISTINCTION	Central	Car, bus	Correct
	Peripheral	Tractor, wagon	Correct
	Alike	Submarine, bicycle	Incorrect
	Different	Cradle, light bulb	Incorrect

APPENDIX E – CHAPTER II

Items used in the semantic odd-one-out task

<u>List of items:</u>

- Set 1: computer – calculator – laptop
- Set 2: computer – computer – binoculars
- Set 3: Computer – tractor – lamb
- Set 4: tractor – tractor – bulldozer
- Set 5: tractor – tractor – train
- Set 6: tractor – binoculars – ostrich
- Set 7: lamb – lamb – sheep
- Set 8: lamb – lamb – tiger
- Set 9: lamb – ostrich – computer
- Set 10: stool – stool – chair
- Set 11: stool – stool – table
- Set 12: stool – spanner – lamb

APPENDIX F - CHAPTER III

Gender differences on response time tasks: means and standard deviations in brackets

	Boys (N = 52)	Girls (N = 53)	Sig.** (2-tailed)
NAMING ABILITY*			
Picture Naming	1757 (193)	1741 (249)	F (1, 103) = .124; p = .726
RAN	828 (186)	763 (197)	F (1, 103) = 3.004; p = .086
MEASURES OF PHONOLOGICAL ABILITY*			
Lexical Decision	716 (200)	700 (231)	F (1, 103) = .142; p = .707
MEASURES OF SEMANTIC ABILITY*			
Semantic categorisation	1244 (163)	1194 (170)	F (1, 103) = 2.370; p = .127
Definition	3055 (971)	2728 (866)	F (1, 103) = 3.311; p = .072
Odd-one-out	3562 (914)	3532 (947)	F (1, 103) = .027; p = .871
MEASURES OF NON-LEXICAL ABILITY*			
Pressing of counter	300 (51)	316 (54)	F (1, 103) = 2.331; p = .130
Simple Motor	423 (93)	418 (95)	F (1, 103) = .062; p = .805
Choice Motor	724 (165)	724 (180)	F (1, 103) = .000; p = .995

* Homogeneity of variances ascertained from Levene's statistic
** Tukey's post hoc test used for multiple comparisons (significance level at .05)

APPENDIX G – CHAPTER IV

Gender differences on accuracy scores: means and standard deviations in brackets

	Boys (N = 52)	Girls (N = 53)	Sig.** (2-tailed)
NAMING ABILITY*			
Picture Naming [out of 30[	16.75 (5.632)	17.55 (6.594)	F (1, 103) = .443; p = .507
RAN [out of 50]	49.07 (1.469)	49.23 (1.49)0	F (1, 103) = .322; p = .572
COMPREHENSION VOCABULARY* BPVS	81. 40 (19.798)	85.04 (18.623)	F (1, 103) = .939; p = .335
MEASURES OF PHONOLOGICAL ABILITY*			
Phonological awareness	9.38 (4.045)	10.58 (4.075)	F (1, 103) = 2.331; p = .130
Lexical decision	32.00 (3.458)	32.17 (3.817)	F (1, 103) = .057; p = .812
MEASURES OF SEMANTIC ABILITY*			
Semantic fluency	21.98 (5.008)	23.91 (5.671)	F (1, 103) = 3.394; p = .068
Semantic categorisation	34.69 (2.719)	34.45 (3.791)	F (1, 103) = .138; p = .711
Definition	8.88 (4.453)	10.38 (5.365)	F (1, 103) = 2.402; p = .124
Odd-one-out	12.71 (6.200)	13.68 (6.664)	F (1, 103) = .593; p = .443

* Homogeneity of variances ascertained from Levene's statistic (except for categorisation task where p = .002)
** Tukey's post hoc test used for multiple comparisons (significance level at .05)

APPENDIX H – CHAPTER V

Coding grid for Visual types of errors

A. Visual errors: These types of responses consist in erroneous word substitutions arising because of visual confusion, whereby a child mislabels the target picture as something else that looks similar (even if they do not share the same function) or children's responses reflect the perceptual attributes (such as colour, shape or size) of the target word.

Substitution Category	Code	Example	Target word	Definition
Visual Substitution	VS	Ball Gun	Bead Drill	Objects are misidentified by other items that look alike
Visual Part-Whole	VPW	Horse Face	Statue Chin	Part of the stimulus is labelled rather than the whole or the whole picture is named rather than the coloured part
Visual Cue	VC	Circle Red	Barrel Patch	Children describe what is on the picture (shape or colour)
Picture Labelling	PL	Cheerleader A spinner	Cheering Spinning	Only used for Verbs. Children use a noun to describe an action sequence

APPENDICES

APPENDIX I – CHAPTER VII

Stories used for introducing the 3 novel words (*celtar*, *genum* and *inlect*) according to the Condition (*Visual, Speech or Combined*).

VISUAL CONDITION

Introduction

This is Sammy, the rabbit.

He was tired of living in his cage with only a bowl of water and a few dirty lettuce leaves. So, one day, Sammy decided to take a trip around the world. Now Sammy is going to show us pictures of some of the strange objects he saw, from each of the different countries he visited.

Listen carefully to the story and look very carefully at the pictures of the objects Sammy will show us. Then we will play a guessing game where we will see how well you can remember the name of the objects that Sammy saw on his travels.

1. CELTAR / Tree

a) This is a "celtar". Look at this tall "celtar", Sammy had never seen anything quite like this before.
b) First Sammy noticed that the 2 dark brownish parts of the "celtar" were set firmly apart and met at the top, so that the "celtar" looked a bit like the letter 'A'.
c) Next, Sammy looked at the bottom of the "celtar". He could see 2 sets of massive yellowish chunks at the bottom of the "celtar".
d) Finally, the top of the "celtar" also interested Sammy as it had a very unusual shape. Sammy wondered if he would see anymore "celtars" on his travels.

2. GENUM / Animal

a) This is a "genum". Another one of the unusual things that Sammy saw was this "genum" that you can see behind these bars.
b) People kept staring at the "genum's" face because it looked really strange. Sammy wondered why the "genum" looked so strange.
c) Also, everyone was afraid to get too close to the "genum". As you can see, the "genum" looks really scary with its large teeth, claws and angry growls.
d) But the strangest thing is that, as soon as people got close, the "genum's" reaction was very funny and friendly. Sammy wondered if he would see anymore "genums" on his travels.

3. INLECT / House

a) This is an "inlect". Sammy saw what people called "inlect", that were all over the countryside.
b) As Sammy got closer to the "inlect", he realized that all the "inlects" had the same shape and they were sitting on wooden platforms.
c) Sammy went to look at the back of the "inlect". He noticed that there were several steps leading upwards. Also, the top of the "inlect" was covered with red coloured dots.
d) By looking closer to the ground, Sammy was surprised to see several little wheels under the platform supporting the "inlect". Sammy wondered if he would see anymore "inlects" on his next trip.

SPEECH CONDITION

Introduction

This is Sammy, the rabbit.

He was tired of living in his cage with only a bowl of water and a few dirty lettuce leaves. So, one day, Sammy decided to take a trip around the world. Now Sammy is going to tell us about some of the strange objects he saw, from each of the different countries he visited.

Listen carefully to the story about the objects that Sammy saw. Then we will play a guessing game where we will see how well you can remember the name of the objects that Sammy saw on his travels.

1. CELTAR / Tree

a) Sammy first saw a "celtar". The "celtar" is a kind of very tall wooden plant that Sammy had never seen before.
b) First Sammy noticed that the "celtar" had 2 dark brown trunks set firmly apart. And the way they met at the top made the "celtar" look like a funny letter 'A'.
c) Next, Sammy looked at the bottom of the "celtar". And he could see 2 sets of massive yellowish roots at the bottom of the "celtar", which seemed to be like shoes at the end of the trunks.
d) Finally, the top of the "celtar" had a crown of leaves. What was unusual was that the branches looked like thin arms that were reaching up to the sky. Sammy wondered if he would see anymore "celtars" on his travels.

2. GENUM / Animal

a) Next, Sammy saw a "genum". Another one of the unusual things that Sammy saw was the "genum", which is a 4-legged type of animal that lives behind bars.

b) People kept staring at the "genum's" face, which looked really strange. Indeed, Sammy thought that the "genum's" face looked as if many animals' characteristics were glued together.
c) Also, everyone was afraid to get too close to the "genum". And that is because this strange creature looked very dangerous with its large teeth, claws and angry growls. Sammy, along with everyone else, was afraid of the "genum" and didn't want to get near.
d) But the strangest thing is that, as soon as people got close, the "genum" behaved like a cute little puppy and was very keen on playing. Sammy was no longer afraid and wondered if he would see anymore "genums" on his next trip.

3. INLECT / House

a) Next, Sammy saw what people called "inlect". The "inlects" were the houses that people lived in, which were all over the countryside. From a distance, they looked a bit like giant mushrooms.
b) Sammy got closer to the "inlects". He realized that all these houses had the same round shape, and he also noticed that the "inlects" were sitting on wooden platforms.
c) Sammy went to look at the back of the "inlect". Round the back of the house, two things caught Sammy's eye. First, there were several steps on one side of the walls that were leading to the top. Also, the roof of the "inlect" was covered with red coloured dots.
d) Finally, by looking closer to the ground, Sammy was surprised to see several little wheels under the "inlect". The "inlects" had wheels underneath, just so that whenever people were tired of living in one place, they could move their houses around – just like snails would carry their houses on their backs.

COMBINED CONDITION

Introduction

This is Sammy, the rabbit.

He was tired of living in his cage with only a bowl of water and a few dirty lettuce leaves. So, one day, Sammy decided to take a trip around the world. Now Sammy is going to show us pictures of some of the strange objects he saw, from each of the different countries he visited.

Listen carefully to the story and look very carefully at the pictures of the objects Sammy will show us. Then we will play a guessing game where we will see how well you can remember the name of the objects that Sammy saw on his travels.

1. CELTAR / Tree

a) Sammy first saw a “celtar”. The “celtar” is a kind of very tall wooden plant that Sammy had never seen before.
b) First Sammy noticed that the “celtar” had 2 dark brown trunks set firmly apart. And the way they met at the top made the “celtar” look like a funny letter ‘A’.
c) Next, Sammy looked at the bottom of the “celtar”. And he could see 2 sets of massive yellowish roots at the bottom of the “celtar”, which seemed to be like shoes at the end of the trunks.
d) Finally, the top of the “celtar” had a crown of leaves. What was unusual was that the branches looked like thin arms that were reaching up to the sky. Sammy wondered if he would see anymore “celtars” on his travels.

2. GENUM / Animal

a) Next. Sammy saw a “genum”. Another one of the unusual things that Sammy saw was the “genum”, which is a 4-legged type of animal that lives behind bars.
b) People kept staring at the “genum’s” face, which looked really strange. Indeed, Sammy thought that the “genum’s” face looked as if many animals’ characteristics were glued together.
c) Also, everyone was afraid to get too close to the “genum”. As you can see, this strange creature looked very dangerous with its large teeth, claws and angry growls. Sammy, along with everyone else, was afraid of the “genum” and didn’t want to get near.
d) But the strangest thing is that, as soon as people got close, the “genum” behaved like a cute little puppy and was very keen on playing. Sammy was no longer afraid and wondered if he would see anymore “genums” on his next trip.

3. INLECT / House

a) Next, Sammy saw what people called “inlect”. The “inlects” were the houses that people lived in, which were all over the countryside. From a distance, they looked a bit like giant mushrooms.
b) Sammy got closer to the “inlects”. He realized that all these houses had the same round shape, and he also noticed that the “inlects” were sitting on wooden platforms.
c) Sammy went to look at the back of the “inlect”. Round the back of the houe, two things caught Sammy’s eye. First, there were several steps on one side of the walls that were leading to the top. Also, the roof of the “inlect” was covered with red coloured dots.
d) Finally, by looking closer to the ground, Sammy was surprised to see several little wheels under the “inlect”. The “inlects” had wheels underneath, just so that whenever people were tired of living in one place, they could move their houses around – just like snails would carry their houses on their backs.

APPENDIX J – CHAPTER VIII

Stories used for introducing the 5 novel words (*celtar, klower, genum, inlect* and *girter*) according to the Condition (*Visual, Speech or Combined*).

VISUAL CONDITION

Introduction

This is Sammy, the rabbit.

He was tired of living in his cage with only a bowl of water and a few dirty lettuce leaves. So, one day, Sammy decided to take a trip around the world. Now Sammy is going to show us pictures of some of the strange objects he saw, from each of the different countries he visited.

Listen carefully to the story and look very carefully at the pictures of the objects Sammy will show us. Then we will play a guessing game where we will see how well you can remember the name of the objects that Sammy saw on his travels.

1. CELTAR / Tree

a) This is a "celtar". Look at this tall "celtar", Sammy had never seen anything quite like this before.
b) First Sammy noticed that the 2 dark brownish parts of the "celtar" were set firmly apart and met at the top, so that the "celtar" looked a bit like the letter 'A'.
c) Next, Sammy looked at the bottom of the "celtar". He could see 2 sets of massive yellowish chunks at the bottom of the "celtar".
d) Finally, the top of the "celtar" also interested Sammy as it had a very unusual shape. Sammy wondered if he would see anymore "celtars" on his travels.

2. KLOWER / Musical Instrument

a) This is Sammy's friend, Fred the donkey.
b) Look, this is a "klower". Sammy visited his friend Fred, the donkey, who showed him his favourite "klower".
c) The shape of the "klower" was like that of a football. And there was also a ring around the "klower".
d) Sammy didn't know how to use the "klower", so Fred showed him by sitting down. Then, Fred held the "klower" up to his mouth and placed his hands over the tiny holes, on each side of it.
e) After he'd finished, Fred took the "klower" apart and placed it back in its special case. Sammy decided he was going to buy a "klower" as he liked it so much.

3. GENUM / Animal

a) This is a "genum". Another one of the unusual things that Sammy saw was this "genum" that you can see behind these bars.
b) People kept staring at the "genum's" face because it looked really strange. Sammy wondered why the "genum" looked so strange.
c) Also, everyone was afraid to get too close to the "genum". As you can see, the "genum" looks really scary with its large teeth, claws and angry growls.
d) But the strangest thing is that, as soon as people got close, the "genum's" reaction was very funny and friendly. Sammy wondered if he would see anymore "genums" on his travels.

4. INLECT / House

a) This is an "inlect". Sammy saw what people called "inlect", that were all over the countryside.
b) As Sammy got closer to the "inlect", he realized that all the "inlects" had the same shape and they were sitting on wooden platforms.
c) Sammy went to look at the back of the "inlect". He noticed that there were several steps leading upwards. Also, the top of the "inlect" was covered with red coloured dots.
d) By looking closer to the ground, Sammy was surprised to see several little wheels under the platform supporting the "inlect". Sammy wondered if he would see anymore "inlects" on his next trip.

5. GIRTER / Car

a) This is a "girter". As you can see, the "girter" is that large, unusual, piece of metal.
b) Sammy did not know what people used this "girter" for. Look, the front of the "girter" was of a dark yellowish colour, and looked very unusual and large.
c) Sammy climbed inside the "girter" and it immediately lurched forwards. Sammy was scared as the "girter" rose unsteadily in the air.
d) Once inside the "girter", Sammy was very surprised at the number of instruments and gadgets that he saw. Sammy wasn't too sure how he felt about the "girter", as this was a very scary experience.

SPEECH CONDITION

Introduction

This is Sammy, the rabbit.

He was tired of living in his cage with only a bowl of water and a few dirty lettuce leaves. So, one day, Sammy decided to take a trip around the world. Now Sammy is going to tell us about some of the strange objects he saw, from each of the different countries he visited.

APPENDICES

Listen carefully to the story about the objects that Sammy saw. Then we will play a guessing game where we will see how well you can remember the name of the objects that Sammy saw on his travels.

1. CELTAR / Tree

a) Sammy first saw a "celtar". The "celtar" is a kind of very tall wooden plant that Sammy had never seen before.
b) First Sammy noticed that the "celtar" had 2 dark brown trunks set firmly apart. And the way they met at the top made the "celtar" look like a funny letter 'A'.
c) Next, Sammy looked at the bottom of the "celtar". And he could see 2 sets of massive yellowish roots at the bottom of the "celtar", which seemed to be like shoes at the end of the trunks.
d) Finally, the top of the "celtar" had a crown of leaves. What was unusual was that the branches looked like thin arms that were reaching up to the sky. Sammy wondered if he would see anymore "celtars" on his travels.

2. KLOWER / Musical Instrument

a) Sammy visited his friend Fred, the donkey, who showed him his "klower". The "klower" was Fred's favourite musical instrument.
b) The "klower" had a very unusual shape, which made Sammy think of a football. But unlike a football, there was also a ring around the "klower".
c) Sammy didn't know how to play the "klower", so Fred showed him by first sitting down. Then, Fred held the instrument up to his mouth and placed his hands over the tiny holes on each side of it. This is how you play a "klower", said Fred.
d) After he'd finished playing the "klower", Fred took the instrument apart and placed the "klower" back in its special case.

3. GENUM / Animal

a) Next, Sammy saw a "genum". Another one of the unusual things that Sammy saw was the "genum", which is a 4-legged type of animal that lives behind bars.
b) People kept staring at the "genum's" face, which looked really strange. Indeed, Sammy thought that the "genum's" face looked as if many animals' characteristics were glued together.
c) Also, everyone was afraid to get too close to the "genum". And that is because this strange creature looked very dangerous with its large teeth, claws and angry growls. Sammy, along with everyone else, was afraid of the "genum" and didn't want to get near.
d) But the strangest thing is that, as soon as people got close, the "genum" behaved like a cute little puppy and was very keen on playing. Sammy was no longer afraid and wondered if he would see anymore "genums" on his next trip.

4. INLECT / House

a) Next, Sammy saw what people called "inlect". The "inlects" were the houses that people lived in, which were all over the countryside. From a distance, they looked a bit like giant mushrooms.
b) Sammy got closer to the "inlects". He realized that all these houses had the same round shape, and he also noticed that the "inlects" were sitting on wooden platforms.
c) Sammy went to look at the back of the "inlect". Round the back of the house, two things caught Sammy's eye. First, there were several steps on one side of the walls that were leading to the top. Also, the roof of the "inlect" was covered with red coloured dots.
d) Finally, by looking closer to the ground, Sammy was surprised to see several little wheels under the "inlect". The "inlects" had wheels underneath, just so that whenever people were tired of living in one place, they could move their houses around – just like snails would carry their houses on their backs.

5. GIRTER / Car

a) Next, Sammy saw a "girter". The "girter" is a strange type of transport that people use when they want to travel from one place to another.
b) At first, the girter" looked like a typical car. However, by looking closer, Sammy noticed that the "girter" was different from a car. Indeed, 2 yellowish headlights made the vehicle look like a frog with its unusually large eyes.
c) Sammy wanted to go for a ride in the "girter". So, Sammy carefully got inside and fastened his seatbelt. Immediately, the "girter" and the whole cabin rose unsteadily in the air on its springs.
d) After recovering from his first shock, Sammy was very surprised at the number of gadgets and navigational instruments that were on the dashboard. The "girter" made Sammy feel like he was in the cockpit of a plane and was ready to take off!

COMBINED CONDITION

Introduction

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b) First Sammy noticed that the "celtar" had 2 dark brown trunks set firmly apart. And the way they met at the top made the "celtar" look like a funny letter 'A'.
c) Next, Sammy looked at the bottom of the "celtar". And he could see 2 sets of massive yellowish roots at the bottom of the "celtar", which seemed to be like shoes at the end of the trunks.
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b) The "klower" had a very unusual shape, which made Sammy think of a football. But unlike a football, there was also a ring around the "klower".
c) Sammy didn't know how to play the "klower", so Fred showed him by first sitting down. Then, Fred held the instrument up to his mouth and placed his hands over the tiny holes on each side of it. This is how you play a "klower", said Fred.
d) After he'd finished playing the "klower", Fred took the instrument apart and placed the "klower" back in its special case.

3. GENUM / Animal

a) Next. Sammy saw a "genum". Another one of the unusual things that Sammy saw was the "genum", which is a 4-legged type of animal that lives behind bars.
b) People kept staring at the "genum's" face, which looked really strange. Indeed, Sammy thought that the "genum's" face looked as if many animals' characteristics were glued together.
c) Also, everyone was afraid to get too close to the "genum". As you can see, this strange creature looked very dangerous with its large teeth, claws and angry growls. Sammy, along with everyone else, was afraid of the "genum" and didn't want to get near.
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